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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 221.

FUNGOUS DISEASES OF THE CRANBERRY.

BY

C. L. SHEAR,
*Pathologist, Vegetable Pathological and Physiological Investigations,
Bureau of Plant Industry.*

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., February 24, 1905.

Sir: I have the honor to transmit herewith the manuscript of an article on the Fungous Diseases of the Cranberry, and recommend its publication as a Farmers' Bulletin.

This paper was written by Mr. C. L. Shear, Pathologist in the Office of Vegetable Pathological and Physiological Investigations of this Bureau, and was submitted by Mr. A. F. Woods, Pathologist and Physiologist, with a view to publication.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FUNGOUS DISEASES OF THE CRANBERRY.[a]

INTRODUCTION.

The cranberry (*Vaccinium macrocarpum*) has been in cultivation in this country for about three-quarters of a century. Some cranberry meadows have been bearing fruit for forty years or more without having been reset. This long-continued growth on the same land and under the same conditions has favored the development and spread of certain fungous diseases which are little known among the wild cranberries. These diseases are apparently spreading and assuming more economic importance each year. The greatest injury from such causes occurs on the New Jersey cranberry bogs. The New England meadows are affected to some extent, but western growers have comparatively little trouble from diseases of this kind.

DISEASES.

Only four of the diseases thus far found attacking the cranberry cause sufficient injury to need consideration here. These are what are popularly called, among growers, cranberry "blast," cranberry "scald," the cranberry rot, and anthracnose. Cranberry blast and scald are really but different effects produced by the same parasitic fungus.

CRANBERRY BLAST.

Cranberry blast is a name given to that form of the disease which attacks the very young fruits as soon as the blossoms fall. It causes the fruit to shrivel up, become black, and finally become covered with one of the spore-producing forms of the fungus, which is a species of *Guignardia*, very closely related to the species which produces the black-rot of the grape. The spores produced upon these young berries are the probable source of infection of most of the other fruit. This fungus, which is represented in its various forms in the accompanying figures, produces two kinds of fruit, or, in other words, passes through two stages of development. The earliest stage, called the pycnidial form, produces its spores in small black spherical receptacles, as shown in figure 1. The spores are furnished with an appendage at the end, as shown in figure 2. This fruiting form of the fungus is the most abundant, and it is probably from this source that most of the leaves and fruits are infected. The second stage in the development of the fungus is that in which the spores are produced in sacs, as shown in figure 3. These are inclosed in receptacles (perithecia), as in the other stage mentioned. Figure 4 represents a single spore from such a sac.

---

[a] The investigations by the Department of Agriculture of the fungous diseases of the cranberry were undertaken at the request of the American Cranberry Growers' Association and the New Jersey Experiment Station.

The results of the technical investigations of the Department upon this subject have not yet been published. The practical success attained in the efforts to control these diseases, however, is of such importance that the methods should be made known to the cranberry growers without delay in order that they may avail themselves of the remedy.—A. F. Woods, *Pathologist and Physiologist.*

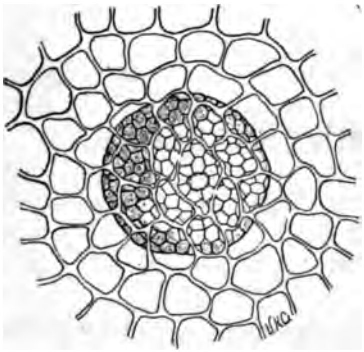

Fig. 1.—First fruiting form of the blast and scald fungus.

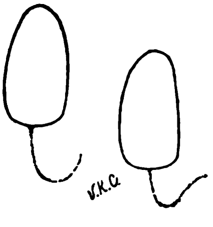

Fig. 2.—The spores of the first fruiting form, much magnified.

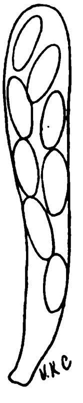

Fig. 3.—Sac with spores from the second fruiting form.

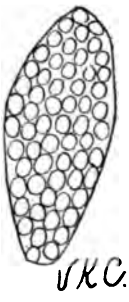

Fig. 4.—Single spore of the second fruiting form, much magnified.

CRANBERRY SCALD.

The name "scald" originated as a result of the belief formerly prevalent among cranberry growers that the injury was due to the effect of the hot sun upon the berries when they were wet, thus producing what was regarded as a real scalding of the tissues of the fruit. Fruit which has been overflowed for a half day or more during hot weather may be injured as a result, and the effect in many instances closely resembles that produced by the scald fungus. A microscopic examination of the berries shows at once the difference. In the berry which has been affected by being covered with water no fungous threads or filaments can be found, whereas in the case of the berry attacked by the scald fungus an abundance of such filaments may readily be observed in the pulp of the diseased berry. Only in the rarest instances does the scald fungus fruit on the berries after they have become half grown.

The disease first becomes noticeable as a small light-colored softened spot on the surface of the berry. This spot rapidly increases in circumference and finally envelops the whole fruit. Sometimes the diseased portion shows more or less distinct brownish zones. In other cases the zones are lacking and the whole fruit becomes very soft and has a light watery color. Figure 5 shows both forms of the disease. In many instances it is very difficult to tell from the external appearance only whether the disease is due to the scald fungus or the rot fungus.

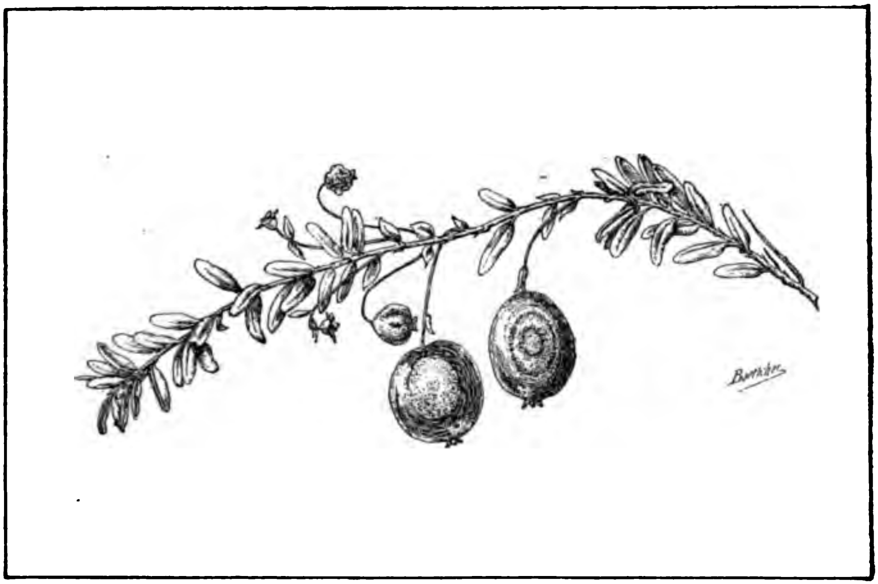

FIG. 5.—Fruit showing scald and blast.

CRANBERRY ROT.

Cranberry rot has until recently been confused with and attributed to the same cause as the scald. Its effect upon the berry is very similar to that of the scald fungus. It is produced, however, by a quite different species of parasite, though belonging to the same large group known as the "black fungi." In some cases where the fruit is in an advanced stage of the disease, the presence of this fungus is indicated by the occurrence of irregular black blotches just beneath the skin of the diseased portion. The amount of injury from the rot is apparently not so great as that from the scald.

CRANBERRY ANTHRACNOSE.

Cranberry anthracnose seems to cause less damage in New Jersey than either of the other diseases just described, but it appears to be more common in Massachusetts and other New England cranberry meadows. It is caused by a species of *Glœosporium*, which closely resembles the species so injurious to the apple and other fruits. The effect of the fungus upon the fruit is very similar to that of the scald and rot, and can be distinguished from them with certainty only by careful examination or cultures made from the tissues of the diseased berries.

All these diseases attack not only the fruit but the leaves. They rarely produce their spores on the leaves until they have fallen or the plant has been entirely killed by the fungi or by some other cause.

REMEDIES AND TREATMENT.

Only preventive measures are available at present in combating these diseases. After the parasites have once entered the tissues of the plant they are practically beyond the reach of remedies. Hence, efforts must be devoted to protecting the plants and keeping them in the maximum condition of health and vigor, as in this condition they are most capable of resisting disease.

It has been frequently noticed that the plants on certain cranberry meadows and portions of meadows suffer much more from rot and scald than others. This is no doubt due in great part, in many cases at least, to the soil and water conditions under which the plants are growing. From personal observations and the experiences of growers it is the opinion of the writer that in the majority of cases the control of the water supply is the most important single factor.

Water supply.—Just what the best quantity of water is and the best way in which to distribute it can only be determined by study and experiment in each case, and will depend largely upon the nature of the soil and subsoil and the nature, contour, and drainage of the land. In general, it may be said that the water supply should be from a reservoir, if possible, and so controlled as to avoid any great fluctuations in the quantity supplied to the plants during the growing season. The cranberry is by nature a water-loving plant, and seems to suffer more frequently from a lack of water than from an excess.

Destruction of dead vines.—Another preventive measure of importance is the destruction of all dead vines and leaves. Frequently small areas of vines die, apparently from the attacks of the cranberry fungi. All h vines should be pulled or cut and collected early in the spring, at st within two weeks after the water has been drawn from the bog, d burned. Vines which have been cut in raking bogs to prepare them r scooping should also be treated in the same manner. Such vines if ot destroyed invariably produce the spores of the cranberry fungi in reat quantities and are a fertile source of infection for the young aves and fruit. Little is to be feared from the rotten berries which ave reached maturity, as the fungi very rarely produce any spores n such berries.

Disease-resistant plants.—It is a matter of common observation among growers that some varieties rot or scald worse than others. Hence, in setting new bogs or replanting old ones the most hardy varieties should be used. By giving careful attention to the selection of disease-resistant plants for propagation, a practically immune variety can probably be eventually secured.

FUNGICIDES.

Several of the best fungicides have been tried for cranberry diseases, especially ammoniacal solution of copper carbonate, potassium sulphid, and Bordeaux mixture. The Bordeaux mixture has proved the most efficient of any used.

Effect of spraying.—The following results were obtained on carefully selected plots where from 75 to 100 per cent of the crop is lost each year from disease. Six plots of one-half acre each were sprayed four times during the season. Alternating with these plots were six others left unsprayed. According to actual counts made from September 8 to 13, 1904, of sound and diseased fruit on 35 yard-square plots, representing the average condition of the sprayed and unsprayed areas, it was found that the maximum of diseased fruit on any of the sprayed plots was 27.5 per cent as against 100 per cent, or a total loss, on the unsprayed plot. The minimum amount of disease on any sprayed plot was 13 per cent as against 89 per cent on the check plot. The average number of diseased berries on all the sprayed plots was 21.7 per cent, while on the unsprayed plots the average was 76.8 per cent. In addition to this there was a noticeably larger crop of fruit on the sprayed plots, and the plants looked more healthy and vigorous. With five applications instead of four it will no doubt be possible to reduce the amount of loss as low as 10 or 15 per cent. Satisfactory results from spraying can, however, be secured only by exercising great care and thoroughness in the preparation and application of the mixture.

Preparation of Bordeaux mixture.—Bordeaux mixture should be prepared as follows:

Copper sulphate (blue vitriol or bluestone)	pounds..	6
Unslaked stone lime	do	4
Water		

To prepare the mixture most conveniently and economically, s solutions of the ingredients should be made. Secure four ba holding at least 50 gallons each, in addition to the barrel which is used for the spray pump. Place 100 pounds of good fresh stone in one barrel and slake the lime by adding water slowly, allowin lime to crack and crumble. After the lime has been thorou slaked, add sufficient water to fill the barrel. When the who thoroughly mixed, as it should be before it is used, it will cont pounds of lime to each gallon.

To prepare the stock solution of copper sulphate place 100 po of copper sulphate in a stout, coarse sack and suspend it in an barrel, which should be filled with water. The bluestone will a dissolved in a day or two if placed as near the top of the barrel as sible. Never place the copper sulphate in the barrel loose, as it take a much longer time to dissolve and will require much stir Each gallon of this solution will now contain 2 pounds of co sulphate.

Make two half-barrels by sawing one of the 50-gallon barrels thr the middle, and put 2 gallons of the stock lime (that is, 4 pou in one barre add suffic water to about 22 gal Stir this we make a thor mixture of lime. Put lons of the copper sul solution (th 6 pounds) in other half b and add en water to make about 22 gallons. Two men with pails can now the two solutions together simultaneously into a barrel, as show figure 6, and then stir the whole thoroughly with a wooden paddl

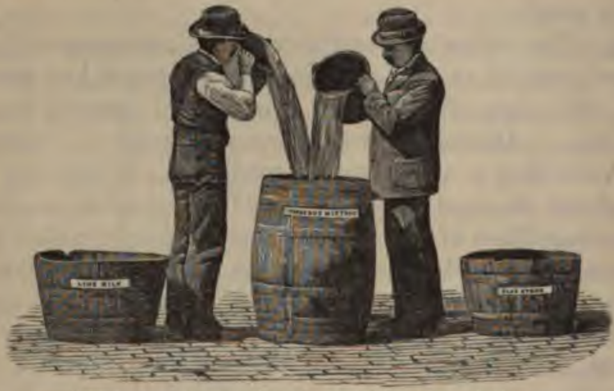

FIG 6.—Pouring together lime and bluestone solutions.

If desired, these stock solutions may be prepared by using on pounds of lime and 50 pounds of bluestone in each barrel. If prep in this way, the solutions would contain 1 pound to each gallon, 4 gallons of lime and 6 of bluestone would be necessary for a 50-g barrel of Bordeaux mixture.

Soap for use with Bordeaux mixture.—To complete the mixture effective use in treating cranberry diseases, it is necessary to add s thing to cause it to spread evenly and adhere to the foliage and f whose smooth, glossy surface causes the plain Bordeaux mixtu either collect in drops or run off entirely. Several soaps have been tried for this purpose, of which resin-fishoil soap has proved the best. This is prepared as follows:

Resin	pounds	5
Potash lye, such as is ordinarily sold for washing purposes	pound	1
Fish oil	pint	1
Water	gallons	5

Dissolve the resin with the oil in a large iron kettle. Let this cool somewhat and then add the potash, slowly stirring the mixture at the same time and watching it carefully to avoid its boiling over. Then add a part of the 5 gallons of water and continue boiling until the mixture will dissolve in cold water. This will require about one hour, when the remainder of the water should be added slowly and the whole thoroughly stirred.

Making the soap.—This soap can be most quickly and conveniently made by using one of the various forms of feed cookers used by farmers for cooking feed, heating water for scalding hogs, etc. These are quickly heated and have a reservoir or kettle capacity of half a barrel or more. In this way a quantity of the soap may be prepared at one time and kept in stock for use as desired. Two gallons of this soap should be added to each 50 gallons of Bordeaux mixture, and the whole should then be strained into the pump barrel through a brass wire-cloth strainer. It is important that the mixture should be well strained, else there will be more or less trouble from the clogging of the spray nozzles. This soap is now being manufactured and placed on the market. If the thick commercial soap is used, 4 or 5 pounds should be diluted in 2 gallons of water and added to each 50 gallons of Bordeaux mixture.

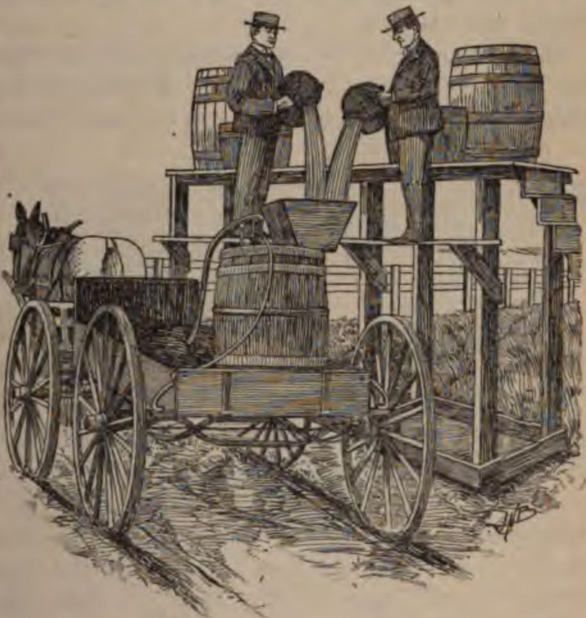

FIG. 7.—Movable platform for use in preparing Bordeaux mixture.

Mixing the ingredients.—A very convenient and time-saving arrangement may be made by constructing a strong movable platform about 6 by 8 feet. This may be placed beside the water supply and as near as convenient to the cranberry vines which are to be sprayed. It may be moved to other places as desired. The floor of the platform should be about 2 feet higher than the top of the spray-pump barrel when it is driven alongside the platform, as shown in figure 7. The height of the platform will, of course, vary according to the spraying apparatus used, being lower in the case of a barrel and cart. Place the two half-barrels used for the separate dilutions of lime and bluestone on the front of the platform and the two barrels containing the stock solutions immediately behind them. By means of a small tank force-pump, pump about 22 gallons of water into each of the half-barrels. A portable pump well adapted to this purpose can be secured for $8 or $10. Now add the necessary quantities of lime and copper from the stock barrels and stir the mixture thoroughly. Then a man standing on the step in front of each half-barrel can pour the two solutions together directly into the strainer of the pump barrel, finally adding the soap.

The strainer.—In this connection a strainer may be described which has been figured by Alwood and Phillips in Bulletin No. 141 of the Virginia Experiment Station. It has been found exceedingly convenient and useful. It consists of a strong, tight wooden box about 12 inches deep, of the form shown in figure 8, A. Bore a hole in the bottom of this box near one side, large enough to screw in a piece of 2-inch gas pipe 6 to 10 inches long. Make another box of lighter material of the shape shown in figure 8, B, which will fit easily into the larger box and project about an inch above it. Tack tightly across the oblique bottom of this a piece of brass wire cloth having 16 or 18 meshes to the inch. On the opposite sides of the projecting portion a narrow strip should be fastened, which will rest upon the upper edge of the outer box, thus preventing the inner box from settling too far down. This strip will also be convenient to grasp in removing the sieve to clean it. The size of the box used will depend upon the space between the opening in the pump barrel and the pump.

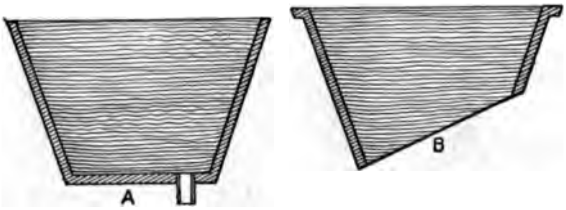

FIG. 8.—Cross sections of box strainer for Bordeaux mixture.

Precautions to be observed.—After the lime and bluestone solutions have been mixed, the preparation should be applied without delay. It should never be allowed to stand for more than an hour before sing, as it will settle and deterioriate in quality. The stock solutions, however, may be kept for a considerable time, without injury. The surface of the lime should be kept covered with water and if not to be used within a few weeks the barrel should be buried in the ground.

Very young and tender foliage may be injured if an insufficient quantity of lime be used. There are two easy methods of determining whether there is an excess of copper in the mixture. Hold the blade of a pocket-knife in the mixture for a minute or two. If the surface of the blade assumes the color of metallic copper, it indicates an insufcient quantity of lime, and more should be added. Another test is the addition of a few drops of a solution of ferrocyanide of potassium. Such a solution may be made by dissolving 1 ounce of the ferrocyanide in 1 pint of water. Pour a little of the Bordeaux mixture to be tested into a white porcelain dish and add a few drops of the ferrocyanide solution. If a reddish-brown precipitate is formed, it indicates an insufficient quantity of lime. It has been found in practice that a slight excess of copper in the mixture does no harm to the foliage of the cranberry plant after the first of July.

Too much emphasis can not be placed upon the necessity of carefully and thoroughly preparing the Bordeaux mixture from good material. There is no doubt that many failures from the use of this mixture are due to lack of proper attention to these matters. Good fresh stone lime should always be used. The ordinary commercial crystals of copper sulphate, costing from 7 to 9 cents per pound, are sufficiently pure for the mixture, as a slight amount of impurity in the form of iron sulphate is regarded by some pathologists as beneficial.

METHODS OF APPLICATION.

The purpose of the application is to prevent the entrance of the fungi into the tissues of the plant. Theoretically, the whole plant should be covered, and particularly the leaves and fruit. Practically, this is of course impossible, but it should be approximated as closely as possible. Only a very thin covering over the surface is necessary. This can only be secured by means of a very fine spray, and in the case of the cranberry by the addition to the Bordeaux mixture of some spreading mixture, such as the resin-fishoil soap, which also adds greatly to its adhering qualities. Thus it resists to a great extent the washing effects of rains.

Apparatus.—A sufficiently fine spray can only be obtained by the use of the very best nozzles. A recently improved form of the Vermorel nozzle has given the best satisfaction in our experimental work. It is also important to have a good pump which will produce the necessary pressure without unnecessary labor and inconvenience.

Three forms of spraying outfits have been tried—the knapsack pump, the barrel and cart or wagon outfit, and a horsepower force pump. The knapsack pump, as illustrated in figure 9, is only adapted for use where small areas are to be sprayed, as the work can not be done rapidly enough. The most rapid method is the horsepower or other power force pump.

In actual experience, several objections to the use of the ordinary forms have been found. In the first place, it is impracticable or impossible in many cases to use a horse on the bogs on account of the soft and miry condition of the land. Where a horse can be used, however, an ordinary horsepower pump does not satisfactorily cover the plants with the mixture. The vines are usually thick and more or less matted, covering the whole surface of the ground, so that it is necessary in order to cover as nearly as possible the surface of the leaves and berries to direct the spray against them from various directions and for a longer time than can be done with a constantly moving pump. The writer has been able to do the most satisfactory work by using a barrel and pump outfit, placing it in a low-bodied wagon, as shown in figure 11, in cases where a horse can be driven on the bog, or

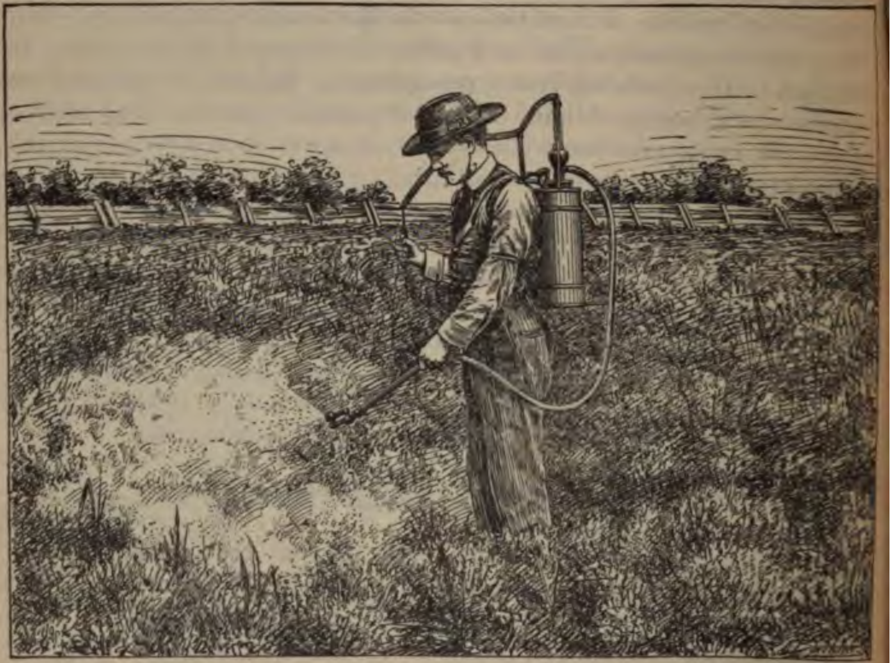

FIG. 9.—Spraying with a knapsack pump.

on a handcart in other cases, as shown in figure 10. Such an outfit, fitted with two 20-foot hose, a 4-foot extension-rod attachment, and two Vermorel nozzles each, can be handled by three men, and a strip 50 feet wide can be sprayed at each trip across the bog.

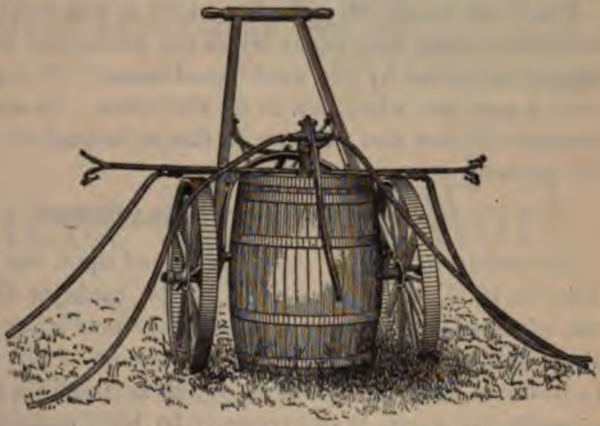

FIG. 10.—A barrel and cart spraying outfit.

Number of sprayings necessary.—At least five applications of the Bordeaux mixture should be made during the season, and not more than fifteen days should in any case elapse between two applications. The first application should be made early in June, the next the latter part of June, just when the blossoms are ready to open, and the third as soon as the plants have passed the height of their blooming period. This application is a very important one, and if thoroughly and properly made should prevent the blasting of the young fruit due to the early attack of the scald fungus. It is best to avoid possible injury which might

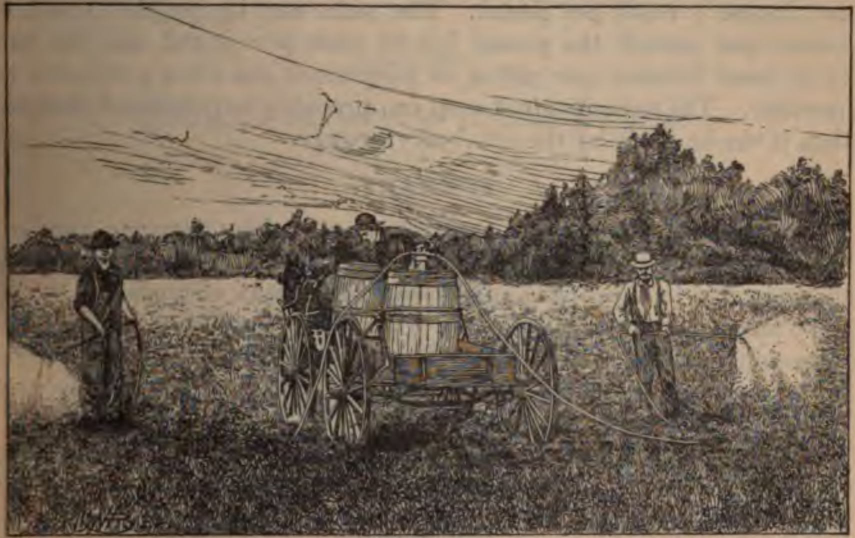

FIG. 11.—A barrel and wagon spraying outfit.

occur by spraying when the plants are in full bloom. The fifth application should not be made earlier than August 15, as it is extremely important that the berries be protected against infection at this time.

The fruit should be picked as early as practicable, in order to avoid infection, which may occur when the protection of the last application begins to be lost by the washing of rains. Do not spray immediately after a rain nor when dew is on the vines. In such cases the mixture becomes diluted and collects in drops instead of forming a film over the surface, as is desired.

COST OF TREATMENT.

According to careful estimates based upon the cost of material and labor in 1904, five applications can be made at the rate of four barrels of Bordeaux mixture per acre at each spraying at an expense of about $15 per acre, not counting the cost of the spraying apparatus. In order to reduce the cost as much as possible and at the same time expedite the work, it is necessary to have materials and apparatus as conveniently arranged as possible. The stock solutions of lime and bluestone, as well as the resin-fishoil soap, should be prepared in quantity and kept near the area to be sprayed. All the materials used in the mixture except the lime can be bought from a wholesale druggist. The cost of copper sulphate crystals in quantity should not exceed 8 cents per pound. The resin may be bought for about 4 cents per pound, the potash lye 10 cents per pound, and the fish oil at about 75 cents per gallon, or very much less when purchased in quantity. The manufactured soap can probably be purchased cheaper than it can be made by the cranberry grower.

SUMMARY.

The cranberry blast, scald, and rot are caused by parasitic fungi.

Spraying experiments have demonstrated that these diseases can be controlled by a proper application of Bordeaux mixture.

To make the mixture effective it must be carefully prepared and thoroughly applied, with the addition of resin-fishoil soap or some other spreading and adhesive mixture. Careless or partial spraying is worse than useless.

At least five applications should be made during the season. No interval of more than fifteen days should elapse between the applications. The last application should not be made earlier than August 15.

It is necessary to use at least four barrels per acre at each spraying. The fruit and vines must be thoroughly covered in order to protect them.

The barrel and cart or barrel and wagon spraying outfit, with two 20-foot lengths of hose, has been found most satisfactory.

The cost per acre for spraying five times during the season should not, according to the methods described here, exceed $15.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 222.

Experiment Station Work,

XXVIII.

Compiled from the Publications of the Agricultural Experiment Stations.

HOME MIXING FERTILIZERS.
SWEET CORN IN THE SOUTH.
KHERSON OATS.
COWPEA HAY.
WEIGHT OF FEEDS.
GRAIN RATIONS.
HORSE FEEDING.
CLASSIFICATION OF SWINE.
SILAGE FOR DAIRY COWS.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

THE AGRICULTURAL EXPERIMENT STATIONS.

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California—*Berkeley:* E. W. Hilgard.[a]
Colorado—*Fort Collins:* L. G. Carpenter.[a]
Connecticut—
  State Station: *New Haven;* E. H. Jenkins.[a]
  Storrs Station: *Storrs;* L. A. Clinton.[a]
Delaware—*Newark:* A. T. Neale.[a]
Florida—*Lake City:* Andrew Sledd.[a]
Georgia—*Experiment:* R. J. Redding.[a]
Hawaii—
  Federal Station: *Honolulu;* J. G. Smith.[c]
  Sugar Planters' Station: *Honolulu;* C. F. Eckart.[a]
Idaho—*Moscow:* H. T. French.[a]
Illinois—*Urbana:* E. Davenport.[a]
Indiana—*Lafayette:* A. Goss.[a]
Iowa—*Ames:* C. F. Curtiss.[a]
Kansas—*Manhattan:* J. T. Willard.[a]
Kentucky—*Lexington:* M. A. Scovell.[a]
Louisiana—
  State Station: *Baton Rouge.*
  Sugar Station: *Audubon Park, New Orleans.*
  North Louisiana Station: *Calhoun;* W. R. Dodson.[a]
Maine—*Orono:* C. D. Woods.[a]
Maryland—*College Park:* H. J. Patterson.[a]
Massachusetts—*Amherst:* H. H. Goodell.[a]
Michigan—*Agricultural College:* C. D. Smith.[a]
Minnesota—*St. Anthony Park, St. Paul:* W. M. Liggett.[a]
Mississippi—*Agricultural College:* W. L. Hutchinson.[a]
Missouri—
  College Station: *Columbia;* F. B. Mumford.[d]
  Fruit Station: *Mountain Grove:* P. Evans.[a]
Montana—*Bozeman:* F. B. Linfield.[a]
Nebraska—*Lincoln:* E. A. Burnett.[a]
Nevada—*Reno:* J. E. Stubbs.[a]
New Hampshire—*Durham:* W. D. Gibbs.[a]
New Jersey—*New Brunswick:* E. B. Voorhees.[a]
New Mexico—*Mesilla Park:* L. Foster.[a]
New York—
  State Station: *Geneva;* W. H. Jordan.[a]
  Cornell Station: *Ithaca;* L. H. Bailey.[a]
North Carolina—*Raleigh:* B. W. Kilgore.[a]
North Dakota—*Agricultural College:* J. H. Worst.[a]
Ohio—*Wooster:* C. E. Thorne.[a]
Oklahoma—*Stillwater:* J. Fields.[a]
Oregon—*Corvallis:* J. Withycombe.[a]
Pennsylvania—*State College:* H. P. Armsby.[c]
Porto Rico—*Mayaguez:* D. W. May.[c]
Rhode Island—*Kingston:* H. J. Wheeler.[a]
South Carolina—*Clemson College:* P. H. Mell.[a]
South Dakota—*Brookings:* J. W. Wilson.[a]
Tennessee—*Knoxville:* H. A. Morgan.[a]
Texas—*College Station:* John A. Craig.[a]
Utah—*Logan:* J. A. Widtsoe.[a]
Vermont—*Burlington:* J. L. Hills.[a]
Virginia—*Blacksburg:* A. M. Soule.[a]
Washington—*Pullman:* E. A. Bryan.[a]
West Virginia—*Morgantown:* J. H. Stewart.[a]
Wisconsin—*Madison:* W. A. Henry.[a]
Wyoming—*Laramie:* B. C. Buffum.[a]

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[a] Director. [b] Assistant director. [c] Special agent in charge. [d] Acting director.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled
m the published reports of the agricultural experiment stations and kindred
titutions in this and other countries. The chief object of these publications
to disseminate throughout the country information regarding experiments at
different experiment stations, and thus to acquaint farmers in a general way
th the progress of agricultural investigation on its practical side. The results
rein reported should for the most part be regarded as tentative and suggestive
her than conclusive. Further experiments may modify them, and experience
ne can show how far they will be useful in actual practice. The work of the
tions must not be depended upon to produce "rules for farming." How to
ply the results of experiments to his own conditions will ever remain the
blem of the individual farmer.—A. C. True, Director, Office of Experiment
tions.

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EXPERIMENT STATION WORK.[a]

HOME MIXING OF FERTILIZERS.[b]

The economy of home mixing has been studied by a number of the experiment stations, as shown in previous numbers of this series.[c] C. D. Woods, director of the Maine Station has recently reported further studies of the subject which yielded results of practical importance.

To make it evident that Maine farmers do and can mix goods that are in all particulars equal to the best factory mixed, the station made in 1904 cooperative experiments upon home mixing with farmers in Brunswick, Houlton, and Fort Fairfield (Maple Grove). * * * A number of farmers at Brunswick clubbed together and purchased bone tankage, cotton-seed meal, nitrate of soda, acid phosphate, and sulphate of potash. The tankage was not in as good mechanical condition as was desirable, but this was remedied by passing it over a screen with 3 meshes to the inch, and rejecting all that did not go through. The coarser particles were not wasted, but were used around fruit trees, etc., where the nitrogen and phosphoric acid would slowly become available and be utilized.

After all of the goods had been screened, samples were taken for analysis. The materials were then weighed and spread out in layers, one above the other, on the barn floor, care being taken to put the bulkiest materials at the bottom. They were then mixed by shoveling together four times and bagged.

The composition of the mixed fertilizer agreed within the limits of error of chemical analysis with that calculated from the composition of the original unmixed materials, thus showing very perfect mixing.

Chemical analyses of a mixture prepared from unscreened goods, assuming shippers' weights to be correct, showed that while there was not as close agreement between calculated and actual composition as in case of the more carefully screened, weighed, and sampled goods, it ran " as close as many of the ready mixed goods sold in the State do to their guaranties. The mechanical condition of these goods was excellent. They were used in the potato planter, and even in the old-type Robbin's planter the fertilizer was distributed as freely and evenly as could be asked. The cotton-seed meal and tankage were so dry that the use of a filler was unnecessary. About 40 acres of potatoes were grown with the above home-mixed goods, the fields being situated in three towns and two counties. * * * In general large crops, ranging in Aroostook County from 275 to 380 bushels per acre, were obtained. On early planted potatoes, and where the season was long enough for the crop grown on the home mixture to mature, the yields were as large as where the standard commercial fertilizers were liberally used."

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Maine Sta. Bul. 107.

[c] U. S. Dept. Agr., Farmers' Buls. 65, 84.

The mixture used per acre in 1904 was:

	Pounds.
Tankage	500
Cotton-seed meal	200
Nitrate of soda	100
Acid phosphate	400
Sulphate of potash	200
Total	1,400

This mixture contained 4 per cent of nitrogen, 7.5 per cent of available phosphoric acid, 11.3 per cent total phosphoric acid, and 7.3 per cent of potash, and furnished 56.1 pounds of nitrogen per acre, 104.7 pounds of available and 158.4 pounds of total phosphoric acid, and 102.6 pounds of potash per acre. As stated, the mixture gave good results when the season was long enough to mature the crop. For quick maturing it apparently carried too much slowly available nitrogen and too little available phosphoric acid.

A mixture for potatoes containing an excess of phosphoric acid which will tend to early maturity is suggested, as follows:

	Pounds.
Nitrate of soda [a]	200
Screened tankage	200
High grade dried blood [b]	100
Acid phosphate	500
Sulphate of potash	200
Total	1,200

This contains 4.7 per cent nitrogen, 6.7 per cent available phosphoric acid, 8.5 per cent total phosphoric acid, and 8.3 per cent potash, and furnishes 56 pounds of nitrogen per acre, 80 pounds of available and 102 pounds of total phosphoric acid, and 100 pounds of potash per acre.

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[a] Or sulphate of ammonia, 75 pounds.

[b] Or dried blood 150 pounds, or cotton-seed meal 200 pounds.

A suggested mixture for potatoes to be used on sod land where a good stubble and aftermath has been plowed under, or in connection with farm manures, is as follows:

	Pounds.
Nitrate of soda	100
Screened tankage	200
Acid phosphate	300
Sulphate of potash	200
Total	800

This mixture contains 3.4 per cent nitrogen, 6.8 per cent available phosphoric acid, 9.2 per cent total phosphoric acid, and 12.5 per cent potash, and furnishes 27 pounds of nitrogen, 54 pounds of available and 74 pounds of total phosphoric acid, and 100 pounds of potash per acre.

These mixtures are intended to supply sufficient fertilizing material for a crop of 300 bushels. "It is to be borne in mind in using these formulas that they are only suggestive and that different conditions of soil make such different treatment essential that a formula which may prove successful on one farm may not be equally so on another." In no case is it to be expected that fertilizers will take the place of good tillage and care of crops.

With these reservations in mind the above formulas for fertilizer mixtures for potatoes and those for various crops which follow may be suggestive and helpful to those who contemplate engaging in the home mixing of fertilizers:

Formulas for fertilizers for various crops suggested by the Maine Experiment Station.

Crop and fertilizing materials.	Weight used.	Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
CORN on sod land or in conjunction with farm manure:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Nitrate of soda	100	16			
Acid phosphate	400		52	64	
Muriate of potash	150				75
Total	650	16	52	64	75
Percentage composition		2.5	8.0	9.9	11.5
Nitrate of soda	100	16			
Screened tankage	200	11	15	82	
Acid phosphate	300		39	42	
Muriate of potash	150				75
Total	750	27	54	74	75
Percentage composition		3.7	7.2	9.9	10.0
Nitrate of soda	100	16			
Cotton-seed meal	200	14		3	4
Acid phosphate	400		52	64	
Muriate of potash	150				75
Total	850	30	52	67	79
Percentage composition		3.5	6.1	7.9	9.3

Formulas for fertilizers for various crops, etc.—Continued.

Crop and fertilizing materials.	Weight used.	Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
GRASS—spring seeding with oats as a nurse crop in conjunction with liberal applications of farm manure:[a]	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Nitrate of soda	100	16			
Acid phosphate	400		52	56	
Muriate of potash	250				125
Total	750	16	52	56	125
Percentage composition		2.1	6.9	7.5	16.5
GRASS—spring seeding with oats without farm manure:					
Nitrate of soda	100	16			
Screened tankage	500	28	36	80	
Acid phosphate	200		26	28	
Muriate of potash	250				125
Total	1,050	44	62	108	125
Percentage composition		4.2	5.9	10.3	11.9
GRASS—summer or fall seeding with farm manure (at seeding):					
Acid phosphate	100		13	14	
Muriate	170				[illegible]
Total	270		13	14	[illegible]
Percentage composition			6.5	7.0	19.0
The following spring apply—					
Nitrate of soda	100	16			
Acid phosphate	200		26	28	
Muriate	250				100
Total	450	16	26	28	100
Percentage composition		3.6	5.8	6.2	22.2
GRASS—summer or fall seeding without farm manure (at seeding):					
Nitrate of soda	100	16			
Screened tankage	400	22	29	64	
Muriate of potash	100				50
Total	600	38	29	64	50
Percentage composition		6.3	4.8	10.7	8.3
The following spring apply—					
Nitrate of soda	100	16			
Acid phosphate	200		26	28	
Muriate	250				100
Total	450	16	26	28	100
Percentage composition		3.6	5.8	6.2	22.2
GRASS—spring top-dressing grass land, suggested by the Rhode Island Experiment Station:[b]					
Nitrate of soda	350	54			
Acid phosphate	400		52	56	
Muriate of potash	250				125
Total	1,000	54	52	56	125
Percentage composition		6.8	6.5	7.0	15.6
CLOVERS, OR ALFALFA, without other manure and on land carrying the proper root tubercle organisms:					
Nitrate of soda	50	8			
Acid phosphate	400		52	56	
Muriate of potash	250				125
Total	700	8	52	56	125
Percentage composition		1.1	7.4	8.0	17.9

[a] If desired to apply by machinery, it would be necessary to mix with about 200 pounds of some fine, dry material, as muck or loam.

[b] Rhode Island Sta. Bul. 90.

Formulas for fertilizers for various crops, etc.—Continued.

Crop and fertilizing materials.	Weight used.	Nitrogen.	Phosphoric acid.		Potash.
			Available.	Total.	
Beans or peas without the manure on soil carrying the proper root tubercle organisms:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Nitrate of soda	50	8			
Acid phosphate	400		52	56	
Muriate of potash	150				75
Total	600	8	52	56	75
Percentage composition		1.3	8.7	9.3	12.5
Mangolds or other beets, based upon experiments at the Rothamsted (England) Experiment Station (to be used in conjunction with a liberal dressing of farm manure):					
Nitrate of soda	400	64			
Muriate of potash	400				200
Common salt [a]	200				
Total	1,000	64			200
Percentage composition		6.4			20.0
Mangolds or other beets without farm manure:					
Nitrate of soda	200	32			
Screened tankage	800	44	58	128	
Sulphate of ammonia (or 300 pounds high-grade dried blood)	200	40			
Acid phosphate	200		26	28	
Muriate of potash	400				200
Common salt	200				
Total	2,000	116	84	156	200
Percentage composition		5.8	4.2	7.8	10.0

[a] Beets are successfully grown in Maine without salt.

It is of the utmost importance in purchasing materials for these home mixtures to buy only on a guaranty of composition and to insist that the materials shall be of standard high-grade quality.

GROWING SWEET-CORN SEED IN THE SOUTH.

There is a popular belief that sweet-corn seed can not be grown year after year in the South without deterioration in quality. Some light has been thrown on this subject recently by the investigations of the Maryland Station.[a] That station has found that in a State as far south as Maryland at least as good or better sweet-corn seed can be and is grown for use within the State as can be grown in New England. The yield obtained in Maryland from Maryland-grown seed is considerably higher than the yield obtained when Connecticut seed is used. "Not only is the yield higher, but repeated observation has shown that the quality of the crop was as good, if not better, and that the plants from home-grown seed stood the climatic changes much better than those from northern-grown seed."

In support of the above claims it is stated that the Stabler family has originated and grown in Maryland three distinct varieties of sweet corn, all of which are recognized as of the highest quality. No seed from the North has been used on the Stabler farm for the past twenty-six years. A Mr. S. N. Hyde, of Baltimore, states that since 1878 he has been growing his own sweet-corn seed for his canning business and for twenty-five years put up a pack from Maryland-grown seed of Egyptian sweet corn that brought the highest price of any canned corn on the American market. In Harford County a Mr. Charles W. Baker in 1904 grew a crop of 500 acres of sweet corn for canning purposes. The variety grown was a strain of Evergreen obtained originally from Connecticut. Mr. Baker grows his own seed and has not changed seed for twenty-five years. In the vicinity of Aberdeen, Md., nearly 7,000 acres of sweet corn was grown in 1904, nearly all from Maryland seed. People in that section have found from experience that if they do not save their own seed they can not expect a good stand of corn.

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[a] Compiled from Maryland Sta. Bul. 96.

These facts indicate that good sweet-corn seed can be grown in Maryland, that the seed does not "run out," and that the development of useful varieties of sweet corn depends more perhaps upon men and methods than upon climate. "The experience at Aberdeen shows that there is no inherent tendency to deteriorate if the variety be kept pure and be grown under ordinary favorable conditions."

One of the difficulties in the way of developing and keeping pure a variety of sweet corn is the ease with which it mixes with other varieties and with field corn.

> Sweet corn and field or hard corn, if planted at the same time, will mix at least a quarter of a mile away, and thus the sweet corn be much injured in quality. Adams Early, which is not sweet corn, will ruin sweet corn blossoming near it at the same time. * * * But the writer has found little difficulty in avoiding the mixing by always planting sweet corn intended for seed a little earlier than any field corn is planted on his or adjoining farms.

The method of selecting seed sweet corn by the different Maryland growers varies. One way which has been found satisfactory is thus stated:

> For many years it has been the custom to select for home planting a small number of ears having the characteristics most desired. Earliness is maintained only by saving the earliest ears from the early corn, and from these earliest ears a small number, known as "double extra," are set aside for the breeding plat. In selecting these double extra ears attention is not only paid to size, length of grain, and length of cob, but to the character of the corn for quality, as denoted by its translucent appearance. Effort is made to practice rigid selection, i. e., not only to have a great many of the right kind of ears, but to plant none of the wrong kind in the breeding plat or near it.

One of the most vital factors in the sweet-corn seed industry is the proper curing of the ears. Sweet corn molds and ferments more easily than field corn. This greatly injures germination. Freezing before curing also injures germination. Some of the difficulties in curing sweet corn are thus pointed out:

> Fire heat used to dry the corn has not proved satisfactory, because it will cause the cob to sour long before it has had time to dry out. Corn thrown in a large pile with or without the husk on will develop heat enough inside of twenty-four hours to injure the germ, sour the cob, and discolor the grain. Sweet corn cut and shocked up like field corn will sour before it dries, unless the weather be both cool and dry enough before winter to escape injury by freezing. Corn left on the stalk untouched until the husk opens will be greatly discolored and injured by a spell of hot, damp weather. If, however, the ears be husked out on a dry day, and allowed to lie a few hours exposed to the direct rays of the sun, the organisms which cause fermentation are killed by the sunshine, and a layer of dried impervious matter is formed over the surface of the corn and the butt end of the cob, which makes it more difficult for fermentation to start in either corn or cob.
>
> The writer's method of curing sweet corn for seed has been developed after many trials and vexatious failures from following other and more laborious methods, and is given with the confident knowledge that up to the present time it is the best method devised yet to save feed and fodder at the same time. Since adopting it there have been no failures. When the husk is dead and loose on the ear, the sooner the ear is removed and put under the shelter the better, for two or three days of rainy, not cloudy, weather may spoil it, even on the stalk. I pick out a bright clear day and commence early in the morning and cut down a small piece of the corn, throwing into piles, and then in the forenoon, when the sun is shining brightly, husk it out as rapidly as possible, throw the corn into small piles on the ground, tie the fodder in bundles, and set it up in small shocks. Then before night haul in the corn and put it on a slatted floor. The floor is made of lath 1 inch thick by 2 inches wide, spaced 1 inch apart. The corn is taken up in baskets, and each basket is turned upside down on the slats, and taken off carefully, so that the ears are left like a pile of "jack-straws," crossed in every direction, many of them standing in nearly a vertical position. Each basketful of corn is emptied in a fresh place, and when all is done the slats will be covered with corn about a foot deep, but so loosely arranged that there is no obstruction to the passage of air between the ears. In this position it dries very quickly and may be put into barrels as soon as all moisture is out of the cob. Each barrel may be covered with a piece of wire cloth held down by the top hoop, and then the barrel turned on its side.

If sweet-corn seed equal in quality to the New England product and heavier yielding can be successfully grown in Maryland, that fact has importance for States still farther south. Prevention from mixing, rigid selection each year, and great care in curing seem to be the essential factors to be observed.

KHERSON OATS.[a]

An important feature of the work of the experiment stations is the introduction of varieties of crops suited to given regions and special conditions, and many valuable additions have thus been made to the list of crops which the country is capable of producing. Much of this work is done by the stations in cooperation with this Department, but some is done independently. A notable recent example of valuable work of this character by an experiment station is the introduction of the so-called " Kherson oats " brought from Russia by Prof. F. W. Taylor, of the University of Nebraska, in 1896, and thoroughly tested by the Nebraska Station as to its adaptability to the corn belt of the United States.

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[a] Compiled from Nebraska Sta. Bul. 82.

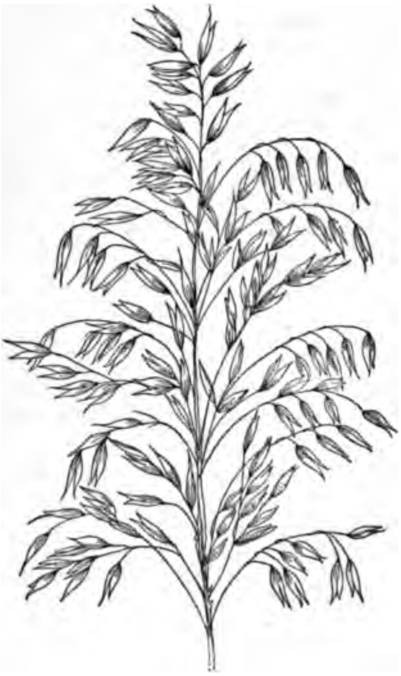

FIG. 1.—Kherson oats.

" The climatic condition most favorable to the growth of oats does not usually obtain in the ' corn belt,' and it has been difficult to find a variety of oats well adapted to this region. It is a curious fact that although the great corn-producing States are the largest producers of oats, they are not States in which the yield per acre is high. An oat to produce well in Nebraska, and particularly in the central and western part, should be very early maturing, and should not run to straw." Such a variety was found in the Kherson Government in Russia, where the soil and climatic conditions (small and uncertain rainfall) are similar to those of the Great Plains.

The Kherson oat is a vigorous but not rank grower. The straw is very short; the leaves are broad and expose a large surface. The panicles are spreading, i. e., it is not a side oat (fig. 1). The berries are light yellow in color, small, but numerous, and have a very thin hull. It usually weighs well per bushel and matures very early.

The results of careful tests of the variety in different parts of Nebraska in 1901 to 1903 indicate that it is " peculiarly suited to central and western Nebraska on account of its habits of growth. * * *

"Although it usually yields well in eastern Nebraska, there are other varieties that in the river counties, at least, compare favorably with it. West of that the tests that have been made of it during the three years indicate that it is earlier, yields better, and weighs heavier than any other variety, with the possible exception of the Texas Red. It has steadily outyielded the Texas Red on the station farm.

* * * In the dry season of 1901 it showed remarkable drought-resisting qualities."

The Texas Red, though approaching the Kherson in yield, is objectionable from a market point of view on account of its color.

The indications are that in introducing the Kherson oats the Nebraska Station has rendered a great service to farmers of that large section of our western domain where the rainfall is too scanty or uncertain to insure good crops of ordinary varieties of oats.

COWPEA HAY.[a]

Well-cured cowpea hay is a most valuable dry forage, ranking much above the common grass hays in feeding value and being at least equal in this respect to good clover and alfalfa hay. With the area of wild grasses decreasing from year to year in certain localities, and the tame grasses in many cases failing to produce adequate yields, a heavy yielding crop with a short period of growth, like some varieties of cowpeas, becomes an important source of hay. The principal reason why the production of cowpea hay is not commensurate with its high value is the difficulty in curing the large succulent vines. Experiments in growing cowpeas as a hay crop and in handling the same economically and successfully during the curing process have been made at the Alabama, Arkansas, and Mississippi experiment stations among others, and the results obtained are here briefly restated in the hope that the information may be of assistance in bringing into practice more effective and less costly methods of curing, and a consequent increase in the production of this kind of hay.

The Alabama Station sought to facilitate curing and to avoid the loss of the leaflets, a most nutritious portion of the plant, which readily break from the vines in curing and handling, by growing cowpeas in a mixture with some grass crop. The principal difficulty here lies in obtaining varieties which arrive at the proper stage for haymaking at the same time with the grass. On good soils German millet grown with the Whip-poor-will cowpea proved useful in facilitating curing. The use of 1 peck of millet seed and 1 bushel of cowpeas per acre is recommended. If grown with a late variety the millet will be ready for cutting while the cowpeas are still too immature to cure well and to make good hay. A test was made of planting Wonderful cowpeas, a late variety, and drilling millet to within 6 inches of the cowpea rows seventeen days later, but still the millet ripened before the cowpeas were ready for haying. While the millet did not add to the yield of hay, Amber sorghum drilled with Wonderful cowpeas on May 14 gave a material increase in the yield, and was ready for mowing at the same time as the cowpeas. The hay of the sorghum mixture was more moist than that obtained from the millet mixtures, and therefore is likely to present greater difficulties in curing; and this will be especially so in unfavorable weather. With these results as a basis, the station recommends growing German millet as an aid in curing early varieties of cowpeas and Amber sorghum as a means of increasing the yield with later varieties.

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[a] Compiled from Alabama Sta. Bul. 118; Arkansas Sta. Bul. 80; Mississippi Sta. Bul. 84; Pennsylvania State Dept. Agr. Rpt. 1903, p. 273.

As long exposure to sunshine causes the leaflets to drop off, curing should be accomplished with the smallest proportion of the mown crop exposed to direct sunshine. Curing is mainly influenced by the weather and the succulence of the vines, and hence the time required for the process varies with these factors. Based on the experience in curing cowpea hay for several seasons, the station suggests the following general course of procedure: "Cutting one day and twenty-four hours later raking into windrows, where the hay may remain twenty-four hours; then cocking and, if practicable, leaving these cocks in the field for two or three days, at the end of which time they may be opened for a few hours before hauling, or hauled without opening, according to the condition of the hay." The use of canvas covers for the haycocks during wet weather was found to be very satisfactory and is believed to pay for itself in the end. An experiment in storing half-cured cowpea hay in a tightly packed condition proved unsuccessful.

From several hundred plats under field conditions the Arkansas Station obtained during five years an average of 3,169.4 pounds of hay per acre. In general, the results did not include the weight of either peas or hulls. In one of the seasons the highest average yield of hay per acre, 8,750 pounds, was obtained from the Clay cowpea, and the lowest, 750 pounds, from New Era and Extra Early Black Eye, the yield of shelled peas from the three varieties being 174, 1,337.5, and 1,025 pounds per acre, respectively. A plat of Wonderful cowpeas yielded 8,350 pounds of hay per acre, and two plats of Clay 8,250 and 7,450 pounds, with practically no pea production. These great varietal variations in the capacity of producing either hay or peas very forcibly calls attention to the advantage of selecting varieties suitable to the purpose for which the crop is grown.

The results in curing the crops on these plats ranged from perfect success to complete failure. Young or vigorously growing vines were difficult to cure even under favorable weather conditions, while mature vines cured with little difficulty in favorable weather and usually made good hay after an exposure of two to four days of rain and cloudiness. The varieties producing few or no peas were most difficult to cure on account of their continued growth and succulent condition until checked by frost. Varieties producing the heaviest yields of peas were most easily cured into hay. Late shallow cultivation prolonged the period of growth, and in order to minimize the difficulties in curing it is suggested that if the crop is intended for hay no further cultivation be given after the first pods are formed. Vines bearing a fair or full crop of peas well ripening together were easily cured when about one-fourth of the peas were ripe and no second growth took place, while if the peas ripened through a prolonged period the plants continued in vigorous growth and were difficult to cure unless the weather was most favorable. Several varieties mown at different stages of growth to observe the effect of the degree of maturity on the curing of the vines for hay ripened their first pods as follows: Warren New Hybrid, August 15; Warren Extra Early, August 20; Whip-poor-will, August 28; Taylor, September 8, and Clay, September 14. The first mowing, made when the varieties were forming their first pods, proved unsuccessful for haymaking. The second mowing, made when the first pods ripened, gave good hay from Warren New Hybrid and Warren Extra Early. The first and second mowings of Clay and Taylor were failures, but good hay was produced from Taylor mown when half or all of the pods were ripe. The number of days from sowing until the first ripe pods appeared was as follows: Warren New Hybrid, 67; Warren Extra Early, 72; Whip-poor-will, 80; Taylor, 90, and Clay, 97 days. Clay is a late grower and did not prove to be a very successful variety for hay.

In another comparison vines of New Era, Black Eye, and Warren Extra Early, after ripening a full crop of peas, cured into good hay ready for storage in two days, and Brown Eye, California Black Eye, Large Black Eye, and Whip-poor-will, with a fair quantity of matured pods, also made very good hay; but several varieties in vigorous growth and with only occasional ripe pods when mown produced hay of very inferior quality.

Where cowpeas are grown between the rows of corn they are frequently harvested by pulling the vines by hand and throwing them into small cocks for curing. This method is applicable only on small farms, and the usual and most practical method of harvesting is with the mowing machine. Varieties of prostrate growth, however, are not very readily cut with the machine, and in growing cowpeas for hay the habit of growth must be taken into consideration and varieties more or less upright be selected in order to facilitate harvesting and curing. New Era, Whip-poor-will, and Wonderful are suggested as being well suited to harvesting with the mower.

Vines having ceased to grow and matured enough for hay may be sufficiently cured for storing in thirty-six or forty-eight hours of favorable weather conditions, and if well cocked after lying a day will endure several days of rainy weather with but slight damage and cure into good hay. On the other hand, green and vigorously growing vines may not cure at all. The following directions for making cowpea hay are given:

> The vines should be cut in the morning as soon as free from dew and when the indications are for favorable haymaking weather. The length of time the vines should remain in the swath depends upon the quantity of vine, degree of maturity, and the weather. A cloudless day, with high temperature, dry air, and high wind, will induce rapid curing, and with a combination of such conditions hay cut in the morning should usually be windrowed or cocked in the afternoon. As soon as the more exposed leaves are well cured, but not dry enough to crumble, the hay should be teddered or, in the absence of a tedder, raked into windrows. Having remained in windrows until the upper portion is well cured, the windrows may be rolled over, that the under portion may be exposed for a time. The hay is then thrown into cocks, where it remains until taken to the barn or stacked.

It is advisable to turn over the cocks a few hours before hauling, in order to expose them to the sun and to hasten curing.

Methods of curing cowpea hay around poles are also described. The vines when thoroughly wilted are stacked about poles 7 to 9 feet long, driven into the ground, and remain there until well cured. When longer and stronger poles are used crosspieces are nailed to them at right angles to each other, about 1 foot above ground and again several feet higher, and so on to the top of the pole. The green but wilted vines are placed about the poles and over the crosspieces to the top, where the stack is drawn to a point and capped. Curing is also accomplished by piling the vines around a simple framework of poles, leaving the stack hollow in the middle, and thus admitting a free circulation of air through the center. These methods of curing, however, involve much labor and expense and are not always practicable.

According to suggestions by Prof. W. F. Massey, of the North Carolina Experiment Station, cowpeas should be harvested for hay as soon as the first pods turn yellow, and the cutting should be done only in the morning under promising weather conditions. The vines should be tossed during the day by means of a tedder or by hand with a fork and raked into windrows that same evening. These are turned and dried the next day and cocked. After the cocks have stood for a day and no further moisture can be wrung from the hay by twisting a handful of it with considerable force it is ready for the barn; but if moisture still appears at the twist the cocks are turned over and rebuilt to hasten the curing and the time when the hay will stand the test.

The following methods of curing cowpea hay are given by W. R. Perkins, of the Mississippi Station:

The cutting is done when the crop is fully mature, which is about the time the pods begin to ripen and the foliage begins to change color.

The mowing-machine blade is kept sharp and run as close to the ground as possible. If the peas are in rows the cutting can be done much cleaner and better with a very sharp hoe and at very little additional cost.

If the weather is good, as is usually the case when the crop is ready, August or September generally, the vines are raked up the same or the following day and put into cocks of the size that two men can handle with a fork when cured. They are left in the cocks for four or five days, being turned over once or twice during the time, then hauled to the barn or stack. In case they are put in a stack a good covering of grass hay is necessary in order to shed the water. The sides of the stack should be built straight up to prevent the water spoiling the outside hay.

Putting in cock is desirable because the hay is then cured by the circulation of air through it, and not in the direct sunlight. Any hay is better when cured in the shade.

If the weather is damp or rainy the hay is not raked at all till cured, when it is carried directly to the place where it is to be stored. If it continues to rain for several days after cutting, do not touch the hay till ready to put up, and then be sure that it is dry when packed away. This is a precaution that must be observed in storing any kind of hay—do not put up when even moist with dew or it will mold.

The crop may sometimes be lost in a protracted wet spell, but can generally be saved in such condition as to make very good forage.

Methods of putting up green are practiced and are entirely satisfactory when the vines are so packed that air can circulate freely through them.

One of the methods of putting up green is to erect a stack pole and nail a strong crosspiece on the pole extending to the outer edges of the stack. Put on a layer of the green vines 2 or 3 feet thick, then nail on another crosspiece, and so on to top of stack, finishing off with grass hay. The crosspieces prevent the vines packing down closely and at the same time allow the air to enter the stack. Hay can be cured and kept by this method. It is somewhat more expensive than curing in the field, as it necessitates the handling of a great amount of water in the green vines, and the cost of stack pole, crosspieces, etc., amounts to something.

WEIGHT PER QUART OF FEEDING STUFFS.[a]

The quart is the measure generally used on the farm, and especially in connection with measuring the rations of concentrated feeds for farm animals. Since such rations can be more accurately stated in terms of actual weight and are always so stated in the more scientific discussions of the subject, it is important to know the weight per quart of the feeds most commonly used. The following table of such weights is given in a recent bulletin of the Massachusetts Experiment Station. This table was prepared by weighing a carefully measured quantity of the several feeds.

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[a] Compiled from Connecticut State Sta. Bul. 147; Massachusetts Sta. Bul. 101.

Average weights of different feeding stuffs.

Feeding stuff.	One quart weighs—	One pound measures—
	Pounds.	*Quarts.*
Barley meal	1.1	0.9
Barley, whole	1.5	.7
Brewers' dried grains	.6	1.7
Corn-and-cob meal	1.4	.7
Corn-and-oat feed	.7	1.4
Corn bran	.5	2.0
Corn meal	1.5	.7
Corn, whole	1.7	.6
Cotton-seed meal	1.5	.7
Distillers' dried grains	0.5- .7	1.0-1.4
Germ oil meal	1.4	.7
Gluten feed	1.3	.8
Gluten meal	1.7	.6
Hominy meal	1.1	.9
Linseed meal, new process	.9	1.1
Linseed meal, old process	1.1	.9
Malt sprouts	.6	1.7
Mixed feed (bran and middlings)	.6	1.7
Oat feed (a variable mixture)	.8	1.3
Oat middlings	1.5	.7
Oats, ground	.7	1.4
Oats, whole	1.0	1.0
Rye feed (a mixture of rye bran and rye middlings)	1.3	.8
Rye meal	1.5	.7
Rye, whole	1.7	.6
Wheat bran	.5	2.0
Wheat, ground	1.7	.6
Wheat middlings (flour)	1.2	.8
Wheat middlings (standard)	.8	1.3
Wheat, whole	1.9	.5

A bulletin of the Connecticut State Station gives in addition to the above—mixed wheat feed, 0.6 pound per quart; provender, 1.5 pounds; rye bran, 0.6 pound.

SUGGESTIONS REGARDING GRAIN RATIONS.[a]

In a recent bulletin of the Massachusetts Agricultural Experiment Station, J. B. Lindsey makes the following practical suggestions regarding grain rations:

> Concentrated feeds differ from roughage in two important particulars: First, all concentrates contain more true starch and less woody fiber, and consequently are more digestible; secondly, most of them contain more protein. The object, therefore, of feeding concentrates is to increase both the total digestible matter and the amount of protein in the daily ration.
>
> It is better to use two or three grains in making a ration than to feed one concentrate exclusively, and the feeder should aim to prepare palatable grain mixtures. Rations should be bulky, to avoid digestive disturbances. Many feeders use from one-third to one-half wheat bran in order to obtain the necessary bulk. Distillers and brewers' dried grains and malt sprouts likewise serve as economical bulky feeds. It is also possible to use corn silage and chopped hay as diluters or distributers of the heavy concentrates.

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[a] Compiled from Massachusetts Sta. Bul. 101.

If bran is used as a base, a very good type of ration may consist, by weight, of:

(1) ⅓ bran, ½ gluten feed, and ⅙ cotton-seed meal.
(2) ⅓ bran, ⅓ cotton-seed meal, and ⅓ corn meal.
(3) ⅓ bran, ⅓ gluten meal, ⅓ flour middlings.
(4) ⅔ bran, ⅓ gluten feed.

One may use dried distillers' grains for bulk and also as a source protein, mixing by weight:

(1) ½ distillers' grains, ¼ flour middlings, ¼ corn meal.
(2) ½ distillers' grains, ⅙ cotton-seed meal, and ⅓ corn meal.

Malt sprouts, also a bulky feed, can be used, mixed with other grains, by weight, as follows:

(1) ¼ malt sprouts, ¼ mixed feed, ½ gluten feed.
(2) ⅕ malt sprouts, ⅖ corn meal, ⅖ gluten feed.

It is better to prepare a considerable amount of the above mixtures at one time, and then feed a definite quantity each day.

In case corn silage is used as a distributer, the mixture may consist, by weight, of:

(1) ⅓ cotton-seed meal, ⅓ flour middlings, and ⅓ corn meal.
(2) ½ corn meal, ¼ cotton-seed meal, and ¼ oat middlings or rye feed.

Care must be taken to see that such combinations are well mixed with the silage.

Seven pounds is the usual quantity to be fed daily to cows producing 10 to 12 quarts of milk. The richer the milk the more food needed. Because of the high prices of concentrates, and in localities where there is not a quick demand for milk, many feeders may find it economy to use but 5 pounds of grain daily, and feed maximum amounts of roughage. Heavy milking Holsteins generally require from 10 to 14 pounds of grain daily, depending upon the milk yield.

It is hardly possible to advise dairymen which ration would prove the most economical, as prices are likely to change so quickly.

Only general suggestions can safely be made, and these must be supplemented in any case by a study of the markets and the exercise of good judgment on the part of the practical feeder in order to get the most economical as well as effective ration.

RECENT HORSE-FEEDING TESTS.[a]

A ration of oats and hay of good quality is generally recognized as a standard in horse feeding and is considered by many feeders indispensable for fancy stock if the best results are to be secured. Nevertheless, in different regions a variety of feeding stuffs are used for horse feeding, and it is true, especially for work animals, that the character of the ration fed is very largely determined by the local food supply. In recent years a number of the experiment stations have carried on investigations which have to do with the value of different feeding stuffs for horses and the ways in which they may be best combined to secure a high degree of efficiency at a reasonable cost, and a popular summary of such work has been published by this Department.[a] Some additional investigations along the same lines are also of interest.

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[a] Compiled from Florida Sta. Bul. 72; Indiana Sta. Bul. 97; Massachusetts Sta. Bul. 99; North Carolina Sta. Bul. 189; Canada Expt. Farms Rpt. 1902, p. 61.

C. W. Burkett, at the North Carolina Experiment Station, made an extended series of studies with farm horses and mules, for the purpose of comparing local-grown feeding stuffs with each other and with purchased feeds, the tests being, in general, so arranged that the rations compared were fed at the same time to each of a pair of animals performing like work under uniform conditions. The principal feeding stuffs studied were bran, cowpea hay, gluten meal, corn-and-cob meal, shelled corn, corn silage and stover, cowpeas, cotton-seed meal, animal meal, and blood meal, a total of 59 rations being tested. During the tests the weights of the animals were taken weekly and the number of work hours recorded. The conclusion was reached that the home-grown forage crops under consideration are adapted to horse feeding, and by their use the purchase of feeds may be reduced to a minimum. Cowpea hay is considered a valuable feed for horses. Combined with corn-and-cob meal it makes a satisfactory working ration and can also be substituted for bran and oats, provided a reasonable quantity of corn is also fed. Two mules weighing about 1,000 pounds each maintained their weight for a period covering about two months on a ration of 10 pounds of cowpea hay, 1.5 pounds of cotton-seed meal, and 15 pounds of corn-and-cob meal, the average cost per day being 19.5 cents.

Corn silage proved a superior feed for horses and mules, one of the most satisfactory rations in the series of tests being made up of 21 pounds of silage, 15 pounds of corn, 2 pounds of bran, and 1 pound of cotton-seed meal. Corn stover was also shown to be an exceedingly valuable feed for farm horses and mules, and the author considers it a good substitute for hay in winter on account of its feeding qualities, high yield per acre, and low market value. Oat hay, cut while in the milk stage, was also found to be a satisfactory feed. When thus harvested it compared favorably with clover hay and cowpea hay.

Considering the nutrients supplied per pound, cotton-seed meal was found to be a relatively cheap feed, and its utilization is spoken of as a matter of great importance, especially for southern farmers. In the North Carolina experiments cotton-seed meal formed a part of the ration in a number of cases, in general with good results, though some of the animals did not at first relish it. The author states that "2 pounds of cotton-seed meal, as a part of the daily rations, was fed to horses and mules with satisfaction. This quantity can be fed either in a mixture with grain or sprinkled on silage or on hay or stover that has been moistened previous to feeding. In comparison with other feeding stuffs, cotton-seed meal, because of its high feeding value, is a relatively cheap feed. Corn stover, corn, and cotton-seed meal, because of feeding and commercial values, make satisfactory rations for winter feeding of horses and mules, or at other times when on light or moderate work."

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[a] U. S. Dept. Agr., Farmers' Bul. 170.

In some of the tests tankage and dried blood were fed, the results as a whole being satisfactory. The dried blood is regarded as especially valuable where horses are run down or thin in flesh. In the case of tankage 1 or 2 pounds was fed per day and in the case of dried blood 1 pound.

As regards the comparative value of different cereal grains and by-products, bran was found to be an acceptable and satisfactory substitute for oats and corn, and in the author's opinion it should always find a place in the ration of work horses where it can be obtained at a moderate cost. The animals fed corn-and-cob meal showed the same efficiency in work and maintained their weight as well as those fed an equal quantity of shelled corn.

When corn on the ear was compared with an equal quantity of corn-and-cob meal, corn stover being used as a coarse fodder, the results were in favor of the ground grain. When clover was used as a coarse fodder there was practically no difference in the two rations. In general it appears that the advisability of grinding corn will depend upon the cost of labor and trouble involved in the operation.

When wheat and cowpeas were compared as part of a ration the cowpeas were considered equal to the wheat or possibly somewhat superior, and, in the author's opinion, are a satisfactory substitute for oats in feeding farm horses and mules. In a test in which cowpeas and oats were compared 4 pounds of each of these feeds was added to a basal ration of 4 pounds of ground wheat, 4 pounds of corn-and-cob meal, and 14 pounds of meadow hay, the cost of the oat ration being 24.4 cents and of the cowpea ration 20.4 cents. In the two weeks of the test the horses had each gained a little in weight and, judged by their appearance and condition, the two rations were equally satisfactory.

From his work as a whole the author concludes that "various kinds of feeding stuffs can be used to advantage and with economy in feeding farm horses and mules. There is no so-called 'one ration for horses.' A mixture of corn and bran, or of corn and cowpeas, or of corn, bran, and cotton-seed meal, is a good substitute for corn and oats in feeding work animals. Any feeding stuff or combination of feeding stuffs that furnishes the necessary and desirable nutrients at least cost should be the important consideration in the preparation of rations for farm horses and mules."

At the Indiana Station, C. S. Plumb compared a brand of dried distillers' grains with oats as a feed for horses. Marked differences were noted in the quantity of the distillers' grains eaten, in one of the tests the average amount being about 7 pounds per head per week with one pair of animals as compared with about 32 pounds per head with another pair. The amount of oats eaten ranged from about 76 to 94 pounds per head per week. It was always found necessary to accustom the horses to the distillers' grains by adding them in increasing amounts to the oat ration. In a second test much the same differences were observed in the amounts of distillers' grains eaten, this feed being so little relished that the quantity consumed by the horses would not have sufficed for the performance of their ordinary work unless other and more palatable feeds had been supplied. In brief, the conclusion was reached that the distillers' grains tested are not palatable horse feed, although judged by their chemical composition they possess a high feeding value. The investigation "simply illustrates the special importance of palatability as a factor in the adoption of food stuffs for use in common practice."

The use of sweet potatoes, cassava, and cane sirup as partial substitutes for corn in a ration for horses and mules was studied by C. M. Conner at the Florida Experiment Station. In the test with sweet potatoes two pairs of horses and two of mules, doing hard work, were used, one animal of each pair being fed approximately 6 pounds of corn, 17 pounds of hay, and 15 pounds of sweet potatoes per 1,000 pounds live weight, and the other some 10 pounds of corn and 15 pounds of hay per 1,000 pounds live weight, the hay used being beggar weed of good quality. After about six weeks the rations were reversed. Little variation in the weight of the animals was observed, except that in some cases there was a gain when sweet potatoes were fed. The sweet-potato ration was cheaper.

> The most important fact brought out in this experiment is that sweet potatoes may be substituted for at least one-half of the corn ration, this substitution being at the rate of 3 pounds of sweet potatoes for 1 of corn. This being the case, an acre of sweet potatoes yielding 150 bushels is equal to a yield of 50 bushels of corn, so far as feeding the work stock is concerned. We do not think that a horse at hard work would do well on an all sweet-potato ration, from the fact that the bulk would be too great for the capacity of the stomach. * * * We have fed one mule for three months on sweet potatoes, cassava, and hay, with good results. He was used for light work about the lot, such as hauling feed, bedding, etc.

Using one pair each of the mules and horses included in the previous test, the value of cassava was studied, one animal of each pair being fed cassava with corn and beggar-weed hay for six weeks, and the others corn and hay. The average amount of cassava eaten was irregular and in general smaller than in the case of sweet potatoes.

"The animals maintained their weights throughout the experiment, which may go to show that cassava is more concentrated than the sweet potatoes. * * * Cassava may be used in about the same ratio as sweet potatoes, but is not so palatable to the animal."

At the close of the cassava test one of the mules was fed for six weeks a ration of corn and low-grade cane sirup and another the regular corn ration. The amount of hay eaten per head was about the same as in the previous tests. Small gains were made on both rations. "Both mules remained in good condition during this experiment in spite of the fact that they were doing hard plowing throughout the entire time." Other tests made at the station show that sirup is relished by all farm animals, and may be fed to work stock "provided it is mixed with chopped hay or something to give it bulk." As regards the use of native hay for draft horses and mules, it is not believed that the local prejudice sometimes expressed is justified. It has been fed exclusively to horses and mules for two years without any unsatisfactory results.

In discussing southern-grown feeding stuffs for horses it is interesting to note that sugar cane is considered a valuable fodder for horses in Africa,[a] though apparently its value for this purpose has not been reported on by the experiment stations in the United States.

W. Godchaux[b] in a discussion of the rational feeding of plantation mules gives data regarding the present system of feeding at a large sugar factory at Assumption Parish, Louisiana, as compared with that previously followed. The ration at present used consists of 8 pounds of corn-and-cob meal, 2 pounds of cotton-seed meal, 11 pounds of molasses, and 15 pounds of pea-vine hay per head, the cost being 14.5 cents. It is estimated that this would supply the nutrients and energy needed for horses and mules at heavy work as shown by Wolff's standard. It is stated that the use of this ration has diminished the cost of feeding mules nearly one-half, while at the same time their health has improved. It is interesting to note the liberal use of molasses and cotton seed in this ration.

A summary of data on horse feeding was recently made by J. B. Lindsey and P. H. Smith at the Massachusetts Station, such topics as suitable feeds (including molasses, among others) for horses, preparation of feeds, digestibility of rations, and watering horses being discussed. A number of rations were suggested, some of which have been tested at different experiment stations or by practical feeders.

Generally speaking, 12 to 15 pounds each of hay and grain daily are sufficient for horses of 1,200 to 1,300 pounds weight doing moderately hard work. Should a portion of the grain consist of cotton seed or gluten meal, it would be

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[a] Natal Agr. Jour. and Min. Rec., 6 (1903), p. [illegible].

[b] Proc. Louisiana State Agr. Soc. and Stockbreeders' Assoc., 1904, p. 71

wise to reduce the grain ration somewhat and increase the quantity of hay. Farmers will naturally prefer to feed a maximum amount of hay and as small a quantity of grain as possible. In view of the high prices usually prevailing for oats the feeder should aim to provide partial or entire substitutes for this grain. Mixtures of corn and bran, or corn, brewers' grains, and bran ought to prove quite satisfactory.

At the Canada Central Experimental Farm, J. H. Grisdale and his associates recorded data regarding the cost of feeding horses, and it was found that the average cost of feed per day was 27.38 cents, and the cost of care 8 cents additional. In a test of the relative value of mixed grains fed with chopped hay, three horses fed 18 pounds of equal parts of ground oats and barley gained 70 pounds in ninety-one days; three fed about the same amount of ground oats and barley 2 to 1 gained 52 pounds, and seven fed 17 pounds of ground oats gained on an average 83 pounds each. All the horses continued in good health throughout the test, and, so far as could be judged, one of the rations was as good as another.

The condition in which the horses are marketed has a decided effect upon their selling price, and it is a common practice to feed them for a longer or shorter period before marketing with a view to inducing gains in weight. W. J. Kennedy,[a] of the Iowa Station, in a discussion of this question points out that a full grain ration with an abundance of forage is needed, and notes that many find clover a satisfactory coarse fodder and corn, oats, and bran a good grain mixture. Cooked or steamed grain twice a week is recommended, with some oil meal or flaxseed added, and glauber salts once a week is said to be useful, especially as the horses are given little or no exercise. Feeding three or four times a day is recommended. Horses on full feed, it is stated, should gain from 3 to 5 pounds per day.

E. A. A. Grange[b] found molasses of value for bringing a horse into condition. He fed 3 quarts of molasses mixed with 6 pounds of finely chopped hay three times a day. At the end of two months the horse had made a gain of 90 pounds.

MARKET CLASSES AND GRADES OF SWINE.[c]

William Dietrich, of the Illinois Station, states that "in selling hogs to the local buyer or shipper the farmer is very often at a decided disadvantage because he can not interpret market reports to the full extent of their meaning, and therefore either does not get what his hogs are worth or loses a sale by asking too much for them." Believing that a better understanding of the market side of the business would be of benefit to the average farmer who has not had opportunity to familiarize himself with market terms and usages, he attempts to explain how swine are classified and graded on the Chicago and other markets.

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[a] Wallaces' Farmer, 28 (1903), p. 1363.

[b] Breeders' Gaz., 43 (1903), No. 24, p. 1178.

[c] Compiled from Illinois Sta. Bul. 97.

The following is given as the classification used on the principal markets:

Market classification of swine.

Classes.	Subclasses.		Grades.
Prime heavy hogs, 350 to 500 pounds			Prime.
Butcher hogs, 180 to 350 pounds.	Heavy butchers, 280 to 350 pounds		Prime. Good.
	Medium butchers, 220 to 280 pounds Light butchers, 180 to 220 pounds		Prime. Good. Common.
Packing hogs, 200 to 500 pounds.	Heavy packing, 300 to 500 pounds Medium packing, 250 to 300 pounds Mixed packing, 200 to 280 pounds		Good. Common. Inferior.
Light hogs, 125 to 220 pounds.	Bacon	English, 160 to 220 pounds	Choice. Light. Fat.
		United States, 155 to 195 pounds	Choice. Good. Common.
	Light mixed, 150 to 220 pounds		Good. Common. Inferior.
	Light light, 125 to 150 pounds		Good. Common. Inferior.
Pigs, 60 to 125 pounds			Choice. Good. Common.

Roughs.

Stags.

Boars.

Miscellaneous:

Roasting pigs, 15 to 30 pounds.
Feeders.
Governments.
Pen holders.
Dead hogs.

By the term choice, in reference to a bacon hog, is meant one that conforms as nearly as possible to the above description. It must have the form that is characteristic of this type of hog, and must have the best quality and condition that is desired for the bacon trade. * * *

To be in good condition a bacon hog must have a good development of lean meat or muscle, with the proper amount of fat as outlined above. He must be smooth, well developed, and have a large proportion of edible meat, while the proportion of fat and other offal must be small. Hams, shoulders, jowls, and neck must also be small in proportion to length and depth of side. If a hog has all these characteristics of form, quality, and condition developed to a marked degree, it would be considered a choice bacon hog. * * *

It may be thought that the production of bacon is possible only with certain breeds of swine and that these breeds will always produce bacon under all circumstances. While this is true in a general way, it is not always true. It is the feed and mode of life that produces the bacon hog and that enables him to retain his form as such after he has been developed.

The bacon-hog type of the United States differs considerably from the English bacon hog, which has recently been introduced into the United States and is rapidly establishing for itself a market class. There is, however, a growing tendency toward the typical bacon type.

There is a demand on the markets of this country from foreign countries, and more largely from our own country, for bacon, and there being few bacon hogs to supply the demand, the trade is supplied from the lighter hogs of the fat or lard hog type. This bacon, however, does not command so high a price on the market as does bacon from typical bacon hogs. The bacon hogs under consideration here weigh from 155 to 195 pounds, and range in age from 6 to 8 months. They are simply hogs selected from the light hogs in general that conform as nearly as possible to the bacon type. They are not very fat, have fairly good development of muscle or lean meat, and are as long and deep inside as is possible to obtain them. About 20 per cent of the light hogs that come to the Chicago market are of this type.

About 55 per cent of the light hogs coming to the Chicago market are said to be of the *light mixed* class, a somewhat miscellaneous class, quite similar, except as to weight, to mixed packing hogs, and containing hogs of the light butcher weights that are too poor in quality, form, and condition for butcher hogs, as well as hogs of the same weight as the bacon hogs, but which are too much of the fat or lard type hog for bacon. "This class, then, is the 'dumping ground' for the outcasts of two former classes of hogs. In one case it takes the poorer hogs and in the other case the better hogs, considered from the fat or lard hog standpoint. * * * Hogs of this class are used principally for the fresh-meat trade. * * * They range in age from 5 to 7 months."

It is stated that about 25 per cent of the light hogs coming to the Chicago market are of the *light light* class, which includes hogs rang in age from 5 to 6 months, and are, as the name indicates, the itest of light hogs. “While the ‘light butchers’ and ‘bacon hogs’ the selected kinds of their respective weight, with consequent all variation between the different grades, the class of ‘light light gs’ includes all the hogs of this weight, consequently the range in e grades is wider. They are used principally for the fresh-meat ide.”

Pigs.—Pigs, as found on the market, range in weight from 60 to 5 pounds, and in age from 3½ to 6 months. This class, like that of ght light hogs, includes all the pigs that range within the given eights. “They are used principally to supply the demand from ie cheaper restaurants and lunch counters, and are in greatest de- iand in winter, being hard to preserve fresh in summer and too oung to cure. About 10 per cent of the hogs coming to the Chicago iarket are of this class.”

Roughs.—This class includes hogs of all sizes that are coarse, rough, ind lacking in condition—too inferior to be classed as packing hogs r as light mixed hogs. “The pork from these hogs is used for the heaper class of trade for both packing and fresh meat purposes. In market reports pigs and roughs are frequently classed together, not because they belong in the same class, but because they sell at approximately the same price. * * *

Stags.—“Stags are hogs that at one time were boars beyond the pig stage and have been subsequently castrated. They sell with a dockage of 80 pounds. If they are of good quality and condition and do not show too much stagginess they go in with the various grades of packing hogs. When they are coarse and staggy in appearance they are sold in the same class with boars. The intermediary grades sell for prices ranging between these extremes, dependent upon their freedom from stagginess and their quality and condition.”

Boars.—“Boars are always sold in a class by themselves and bring from $2 to $3 per hundredweight less than the best hogs on the market at the same time. They always sell straight, with no dockage. There are no distinction as to grades; they simply sell as boars. Of course, if there are marked differences as to quality and condition, the price varies a little accordingly. The pork from these animals is used to supply the cheaper class of trade, and also for making sausage.”

Miscellaneous.—*Roasting pigs* are not generally quoted in market reports. They come to market in small numbers and only during holiday seasons, and their price varies greatly.

Feeders are hogs bought on the market and taken back to the country to be further fed, a practice which is followed only to a very limited extent.

Governments are hogs rejected by the Government [illegible] sound in every respect. "They are usually bought up by a local dealer and taken to one of the smaller packing houses, where they are slaughtered under the supervision of an inspector. If found to be affected so as to make their flesh unfit for human food they are condemned, slaughtered, and tanked. The tank is a large, steam-tight receptacle, like a steam boiler, in which the lard is rendered under steam pressure. This high degree of heat destroys all disease germs with which the diseased carcass may have been affected. The product of the tank is converted into grease and fertilizer."

"The commission men who sell the stock as it comes to the yards and the speculators who handle part of it, pay nothing for their privilege of doing business in the yards. They hold their respective positions by common consent and their respective pens by keeping hogs in them." These hogs are called *pen holders*, and have no influence on the market.

Dead hogs are those killed in the cars in transit, and are used for the manufacture of grease, soap, and fertilizer. "If they weigh 100 pounds or over they sell for 75 cents per hundredweight. If they weigh less they furnish no revenue to the producer or shipper, the cost of handling the same being held equal to their value."

> About two-fifths of the world's hog supply is produced in the United States, and about six-sevenths of these are produced in the Mississippi Valley; hence this section of country has developed the fat or lard hog and has set the standard for hogs in other parts of the United States. * * *
>
> The fat or lard hog is such because corn has been his principal feed and because there has been a demand for pork from such a hog, and he will conform to the present prevailing type just as long as corn remains his principal feed. * * *
>
> Butcher hogs are the best hogs from the fat or lard hog standpoint that come to market, and should be used as a standard for comparison.
>
> From the bacon market standpoint the English bacon hog is the ideal toward which hogs are being developed.
>
> To the close observer it is apparent that the gradually changing conditions brought about by the development of the United States, and the increase in the price of corn resulting from its varied commercial uses, cause the hog to be fed a more mixed and usually a more nitrogenous ration. This will in the future affect the type of the hog of the United States, so that it will more nearly approach that of the English bacon hog.

An obvious deduction from the bulletin is the advantage of uniformity in the lots of hogs shipped to large markets, which conform to recognized classes. The chief purpose of the bulletin is to explain the system of grading or classifying hogs, in order that the farmer may understand the market side of the business more thoroughly and be better able to interpret the market reports. This classification is necessarily somewhat flexible in its application, depending upon individual judgment; and hence there is greater opportunity for ifference of opinion in the case of an uneven lot of hogs. In the igher grades especially uniformity is quite desirable, and a few. ferior animals may bring down the price of the whole lot, as they jure its appearance. As Mr. Dietrich points out, this lack of niformity and the lack of condition is responsible for certain mixed " classes which are made the dumping ground for the outsts of the higher grades. Such mixed lots sell at a disadvantage. peculators take advantage of this, buying several carloads, which ey sort into various classes and resell at a profit because they are roperly graded.

SILAGE IN PLACE OF GRAIN FOR DAIRY COWS.[a]

In a recent bulletin of the Ohio Station C. G. Williams says: " The revailing high prices of grain feeds in the face of very moderate rices for dairy products have reduced the dairyman's profit to a oint where it is a question with him whether he can make the cow y for the large grain ration he has been accustomed to feed. If he n dispense with half the grain he has been feeding without mateally reducing his production of milk and butter fat, his chances for ofit have increased."

During the winter and spring of 1904 the Ohio Station conducted experiment with ten dairy cows, representing five different breeds, to determine what effect the feeding of more silage than is usually d by dairymen, with a corresponding reduction in the grain portion the ration, might have upon the production of milk, butter fat, in in live weight, cost of the ration, and consequent profit. * * *

" The general plan of the experiment was to compare two rations hich should carry as nearly as possible the same amount of dry matr and nutrients. In one ration these nutrients were to be derived rgely from roughage, mainly silage; in the other ration no silage as to be fed and as little roughage as seemed wise, the bulk of the utrients being derived from concentrates." The two rations fed rried practically the same amount of dry matter. In one over 50 er cent of this dry matter was derived from silage and less than 18 er cent was derived from grain. In the other over 57 per cent of the ry matter was derived from grain, no silage being fed.

" The silage used in this test was a mixture of 1 ton of soy beans nd cowpeas to 2½ tons of silage corn. There were nearly twice as nany soy beans in the mixture as cowpeas. The silage corn was very ow in dry matter, owing to an unfavorable season." The silage as ed contained 18.63 per cent of dry matter, 2.36 per cent of protein, .68 per cent of crude fiber, 0.92 per cent of fat, and 9.36 per cent of nitrogen-free extract, being richer in protein and poorer in carbohydrates than average corn silage on account of the admixture of soy beans and cowpeas.

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[a] Compiled from Ohio Sta. Bul. 155.

The figures used in estimating the cost of the different rations were as follows: Silage 10 cents per hundredweight, hay 30 cents, stover 20 cents, wheat bran 93.7 cents, corn meal $1, oil meal $1.16¼, butter 25½ cents per pound, and skim milk 15 cents per hundredweight.

The value placed upon a ton of silage is based upon that of the corn and stover grown upon similar ground and marketed as such. For instance, upon ground on which we average 50 bushels of shelled corn per acre we grow 15 tons or better of silage corn. The 15 tons of silage corn, therefore, may be said to be worth the market value of the 50 bushels of corn plus the 1¼ tons of stover which will go with it. (We find the expense of putting an acre of corn into the silo to be practically the same as shocking, husking, and cribbing the grain and hauling off the stover.) We have here charged 51 cents per bushel for corn on the average for the period covered by the test and $4 per ton for stover. This will make the acre of silage corn worth $30.50, or $2.03 per ton.

The price credited for butter fat is based upon the wholesale price of Elgin butter, as quoted in current publications. The customary one-sixth is added to the fat for the butter equivalent. * * * Eighty per cent of the total milk yield is assumed to be returned as skim milk.

The cows fed the silage ration produced 96.7 pounds of milk and 5.08 pounds of butter fat per hundred pounds of dry matter; those fed the grain ration produced 81.3 pounds of milk and 3.9 pounds of butter fat.

The cost of feed per hundred pounds of milk was $0.687 with the silage ration and $1.055 with the grain ration. The cost of feed per pound of butter fat was 13.1 cents with the silage ration and 22.1 cents with the grain ration. The average net profit per cow per month (over cost of feed) was $5.864 with the silage ration and $2.465 with the grain ration.

Comparing the average daily product of each cow for the entire test with her average daily product for the month previous to the change in ration (or the first month of their test in the case of two cows), the cows fed the silage ration shrank 2.84 per cent in milk and gained 1.89 per cent in butter-fat production. The cows fed the grain ration shrank 9.11 per cent in milk and 14.18 in butter-fat production. Upon the conclusion of the experiment each lot of cows was found to have gained in live weight—the silage-fed cows an average of 47 pounds per head; the grain-fed cows an average of 57 pounds per head.

The facts reported seem to justify the conclusion that silage can be made to take the place of a considerable portion of the grain ration. It is believed that by growing more of the feeds rich in protein—clover, alfalfa, soy beans, cowpeas, field peas, vetches—and ensiling them, or feeding them as hay, it will be possible to further reduce the amount of grain fed.

O

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 223.

MISCELLANEOUS COTTON INSECTS IN TEXAS.

BY

E. DWIGHT SANDERSON,

Special Agent, Bureau of Entomology, in Cooperation with the Entomological Department, A. and M. College of Texas.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL

U. S. Department of Agriculture,
Bureau of Entomology,
Washington, D. C., April 18, 1905.

Sir: I have the honor to transmit herewith the manuscript of a Report on Miscellaneous Cotton Insects in Texas, prepared by Prof. E. Dwight Sanderson, formerly State Entomologist of Texas.

This report is the result of a year's work on the minor insect enemies of the cotton plant, undertaken by Professor Sanderson and his assistants in order to supplement the work which has been done by the field agents of this Bureau, on the more important injuries by the cotton boll weevil and bollworm. It is written in popular form, and I recommend its publication as a Farmers' Bulletin.

Mr. Sanderson desires to acknowledge the valuable assistance given to him in the conduct of these investigations by Mr. A. C. Lewis, who was in charge of the laboratory at the demonstration farm of Mr. E. H. R. Green, at Terrell, Tex., and to Mr. C. C. Sanborn, who had charge of the laboratory work at College Station. A great part of the life histories of the insects discussed in the report is the result of the work of these gentlemen.

Very respectfully,
L. O. Howard,
Entomologist and Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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MISCELLANEOUS COTTON INSECTS IN TEXAS.

INSECTS WHICH AFFECT THE YOUNG PLANTS.

Prior to the advent of the Mexican cotton boll weevil (*Anthonomus undis* Boh.) the retardation of the cotton crop on account of replant-ig, necessitated by the depredations of insect pests on the young lants, was of little importance. But since it is absolutely essential to ature an early crop of cotton if injury by the boll weevil is to be caped, the matter of the injury to the young plants by other insects ecomes a matter of much importance.

CUTWORMS.

As soon as the young plants have started to grow, and often after ey have been chopped, many of them are destroyed by cutworms, hich cut off the stems and often ake replanting necessary over con-lerable areas.

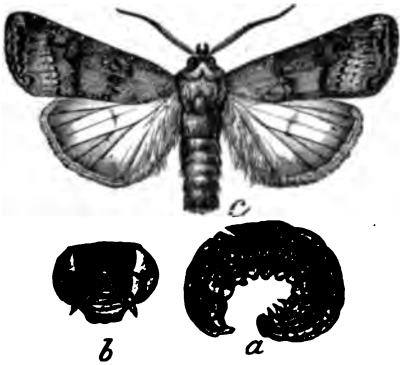


FIG. 1.—*Agrotis ypsilon*, one of the tobacco cutworms: *a*, larva; *b*, head of same; *c*, adult—natural size (after Riley & Howard).

Life history.—The complete life story of the species concerned is t known, but the winter is passed the larval condition in all stages growth, and in the southern part the State more or less damage done to gardens throughout the nter in open seasons. Early rden crops are injured worst in arch, the injury often commencing the middle of February and con-uing until the middle of April or st of May. When full grown the cutworms form oval cells in the il and transform into pupæ, the adult moths emerging three or four eeks later. The species most commonly found on cotton in 1904 were e black cutworm (*Agrotis ypsilon* Rott.), the moths and larvæ of hich are shown in figure 1, and the shagreened cutworm (*Feltia alefida* Guen.). Injury to cotton by cutworms was not as serious in 04 as often occurs, and it is probable that several species other than ose mentioned above were concerned. The moths appear from the middle of May to the middle of July. Both larvæ and moths are nocturnal insects, the larvæ feeding and the moths flying only at night. Planters report that cutworms are more abundant in seasons following a fall in which there have been abundant rains, making grass and weeds plentiful, and that these insects are more injurious at the sides of the fields, where, of course, vegetation was probably abundant the fall previous.

Remedies.—From the habits above outlined it may be seen that much can be done to control these pests by thorough cultivation of the land during late fall, winter, and early spring. When the land is thoroughly plowed many of the cutworms are exposed to abnormal weather and succumb, many are crushed, and still others are eaten by birds or insects. Then, too, when the land is fallow in early spring there is nothing upon which the cutworms can feed and these starve before the cotton is planted. If found abundant in spring, however, they may be best combated by the use of poisoned traps. The mash described on page 10 for grasshoppers will be found very satisfactory, but is rather expensive for large areas. In its place, grass, clover, or other rank vegetation poisoned with Paris green will be found effective if scattered over the field in small bunches a few days before the plants appear. Bunches of the grass may be dipped in Paris green, 1 pound to a barrel of water, or a small area of grass or clover may be thoroughly sprayed and then cut and distributed from a wagon. These traps will be most successful where the land has been plowed some time before, for cutworms will often feed for several days where there is much vegetation which has been but recently turned under.

PLANT-LICE.

With the formation of the first true leaves of the cotton, winged plant-lice or aphids appear in large numbers on the under side of these leaves and on the terminals, the "buds" of the plants often being black with them. Almost all of these are of the same species as that which infests melons later in the season, namely, *Aphis gossypii* Glov. (fig. 2). It may not be out of place, therefore, to call attention to the undesirability of planting cotton between rows of melons, as is often done. The plant-lice migrate to the cotton at this time from various common weeds upon which they have passed the winter.

Another plant-louse, *Aphis* sp., which is most commonly found on bur clover, occurs on the cotton plant at the same time and can not easily be distinguished from the first-mentioned species. In cold weather these plant-lice often cause considerable injury to the cotton plants and greatly retard their development, since they multiply very rapidly and feed mostly on the growing terminals. If there be a few warm days, however, hordes of small parasitic flies appear and in a few days often completely rid the plants of aphids.

Remedies.—Although these plant-lice may be readily destroyed by spraying with kerosene emulsion, whale-oil soap, or tobacco water, as the writer has demonstrated, yet it would hardly seem, judging from his observations, that the use of these insecticides will as a rule be profitable in this particular case. Fall and winter plowing which will keep the fields clear of weeds during the winter will undoubtedly have a beneficial effect in reducing the numbers of plant-lice, and in some cases will be the only treatment necessary.

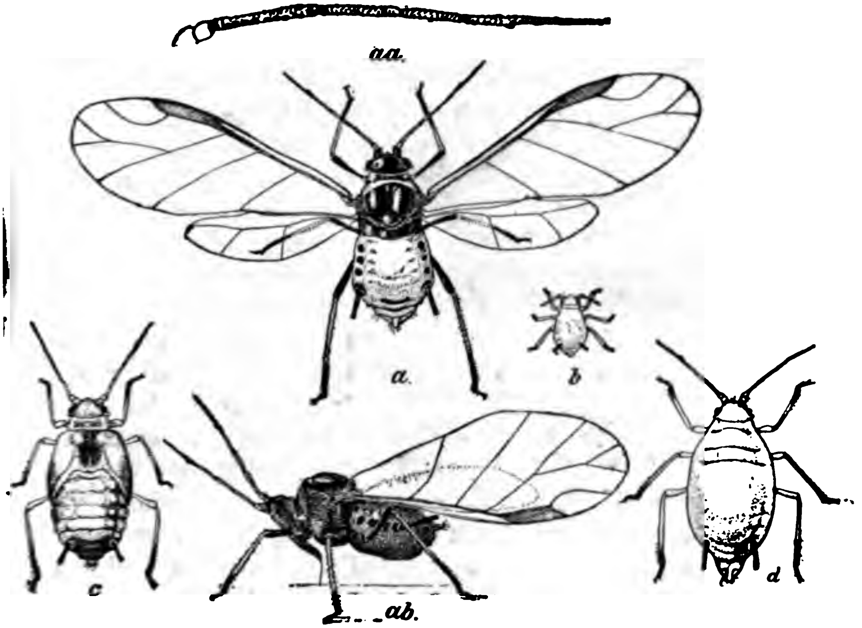


FIG. 2.—*Aphis gossypii*: *a*, winged female; *aa*, enlarged antenna of same; *ab*, dark female, side view; *b*, young nymph or larva; *c*, last stage of nymph; *d*, wingless female—all greatly enlarged (after Chittenden).

THE GARDEN WEBWORM.

The so-called "webworms" or "careless worms" (*Loxostege similis* Guen.) often destroy young cotton and corn over considerable reas, as was especially the case in northern Texas and in Oklahoma in 903. The name "careless worm" is derived from the normal food lant of the species, the "careless weed" (Amaranthus), upon which hese webworms always feed by preference. It is in fields grown up these weeds that the caterpillars are always worst, and if these are ept down the insects will be much less troublesome.

Life history.—The winter is passed in the ground either in the larval or pupal stage and the first moths appear by the middle of April. These moths are of a yellowish-buff color, with markings as shown in figure 3, *a*. Their eggs, which, to the number of 50 per moth, are deposited in bunches of from 8 to 20 upon the leaves of the food plant, and hatch in about three days. The larvæ of the first two broods feed upon weeds, or often upon alfalfa, where that is grown, in which case they are driven to migrate to adjoining cotton when alfalfa is cut. The full-grown caterpillars are slightly over an inch long and of a yellowish or yellowish-green color, marked with shining black tubercles, or warts, as shown in figure 3, *b*. The second brood of larvæ, which occurs in late May and the first half of June, is the one most injurious to cotton. In feeding, the caterpillars spin a fine web which envelops the leaves of the young cotton plant. When full grown they enter the soil and there transform to pupæ (see fig. 3, *f*), from which the moths emerge in about eight days, or just a month from the time the eggs were laid. As a rule, no appreciable injury is inflicted on older cotton, but in August alfalfa is often damaged. There seem to be five, and possibly six, broods a year in Texas. Corn and all kinds of garden vegetables are injured at about the same time as is cotton.

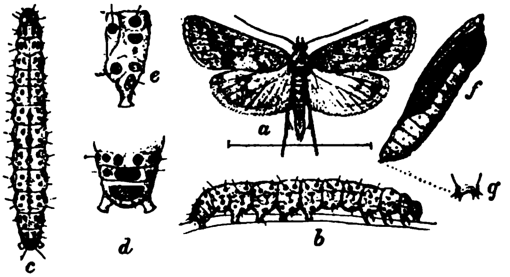


FIG. 3.—*Loxostege similalis*: *a*, male moth; *b*, larva, lateral view; *c*, larva, dorsal view; *d*, anal segment; *e*, abdominal segment, lateral view; *f*, pupa; *g*, cremaster—*a*, *b*, *c*, *f*, somewhat enlarged; *d*, *e*, *g*, more enlarged (reengraved after Riley, except *c*, from Chittenden).

Remedies.—It is evident that fall and winter plowing, not only of cultivated land but also of adjoining fields grown up to weeds, is the most effective means of controlling this pest. Upon their appearance the caterpillars may be easily destroyed by dusting with Paris green or any similar arsenical which will not burn the foliage. This may be best accomplished by means of a powder gun which will distribute a small but ample amount of the poison evenly over the plant, thus economizing in the amount of material used and avoiding the burning of the tender foliage which might result from the heavier application by means of a bag. The planter will find that the prompt application of Paris green will be entirely effectual.

THE WHITE-LINED SPHINX CATERPILLAR.

The larvæ of the white-lined sphinx moth (*Deilephila lineata* Fab.) are common inhabitants of fields of young cotton, but usually do not work any appreciable amount of injury. They are subject to considerable variation in color, being either yellowish-green with black eye spots and faint stripes, or black with yellowish spots, as shown in figure 4. They may be readily distinguished from all other caterpillars on cotton by the pointed horn at the end of the body. Occasionally they become excessively numerous and, assembling in great numbers, somewhat like the army worm, destroy all low-growing vegetation in their path. Such was the case in 1903, when late in May serious damage was inflicted on cotton and garden crops in several localities in southwestern Texas.

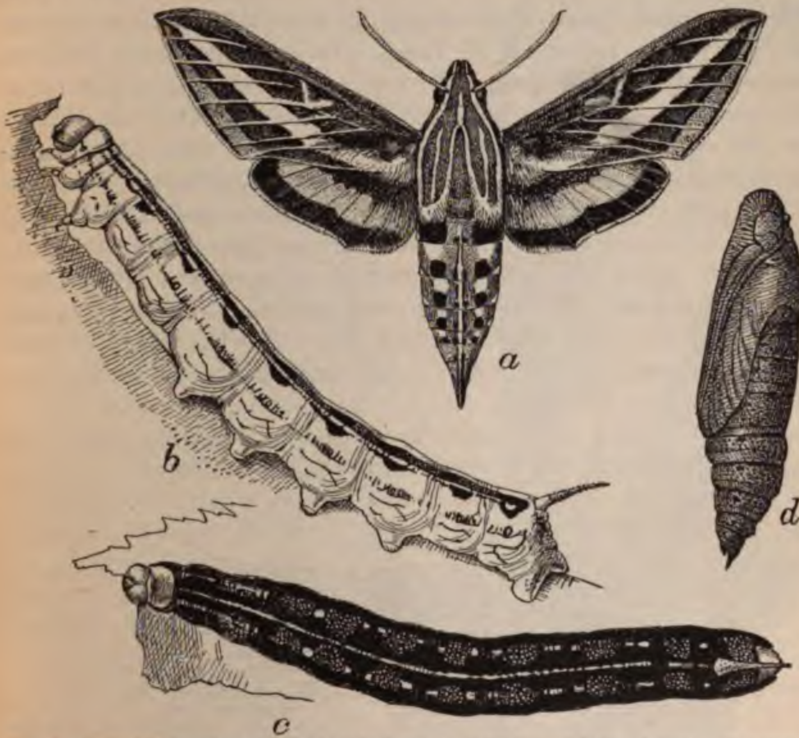


FIG. 4.—*Deilephila lineata:* *a*, moth; *b*, pale larva; *c*, dark form of larva; *d*, pupa—all natural size (from Chittenden).

Life history.—When full grown the caterpillars enter the earth to pupate and the moths emerge about July 1. Usually most of the moths fail to emerge, however, as the caterpillars are parasitized by one of the tachina flies to such an extent that but few transform. The second brood is therefore very small and does no harm. The winter is passed in the soil in the pupal stage.

Remedies.—The favorite food of these caterpillars is purslane, though many succulent weeds are among its common food plants. Here again, therefore, the destruction of these weeds and thorough winter plowing are the best means of control. The caterpillars are readily seen and may easily be destroyed by hand while chopping the cotton; and this should be done, as one caterpillar can destroy several plants if left unmolested. When present in large numbers they may be readily destroyed by dusting the vegetation upon which they are feeding with Paris green.

GRASSHOPPERS.

The differential locust (*Melanoplus differentialis* Thos.) is by far the most injurious grasshopper in Texas. In the summer of 1903 the adults severely injured cotton and corn in the south-central part of the State; and in the spring of 1904 the young, just after they had hatched from the eggs, destroyed the young cotton and corn plants to an alarming extent throughout several counties in this section, but particularly in the bottom lands along the Brazos River and its tributaries. The eggs commenced to hatch in numbers by the middle of March, 1904, and by April 1 the young were present in many fields in countless numbers, destroying the young plants and necessitating replanting over large fields. The eggs had been laid along the edges of cultivated fields, along ditches, and in fields which had been uncultivated the previous year. (See figs. 5 to 8.)

Remedies.—It was found that by thoroughly dusting the weeds around the fields with Paris green, either pure or diluted with flour, great numbers of the nymphs were killed. In addition, a large spoonful of poisoned bran mash was placed every 3 feet in the row throughout the fields and the plants were dusted. This treatment proved very effective, 20 or 30 dead grasshoppers being found near a pile of the mash. This mash is made by stirring 1 pound of white arsenic or Paris green into 25 pounds of bran or middlings and then adding 1 quart of cheap molasses diluted with sufficient water to thoroughly moisten the whole mass, but not so much as to make it doughy. If too moist it cakes too quickly in the sun. It was found that the mash was nearly as effective without the molasses. Where the young hoppers occurred in immense numbers—for they often formed a small cloud when first disturbed—they were sprayed with pure kerosene or crude petroleum, or a soap emulsion containing

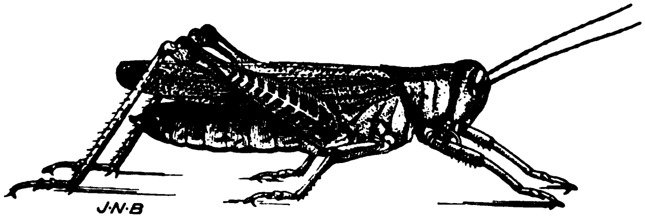


FIG. 5.—*Melanoplus differentialis*: adult—enlarged (original).

about 15 per cent kerosene or crude petroleum. Results with the pure oils were more quickly apparent, so that these were preferred by the planters. Thousands of grasshoppers were thus destroyed within a few square feet. By a thorough use of these methods, as local circumstances warranted, the planters were able to so reduce the numbers of grasshoppers that they did but little damage after the latter part of April. About this time, also, large flocks of ricebirds and blackbirds appeared and fed on the grasshoppers for several days. Had the outbreak remained unchecked several replantings would have been necessary, and a recurrence of the pest the next season would have been probable.

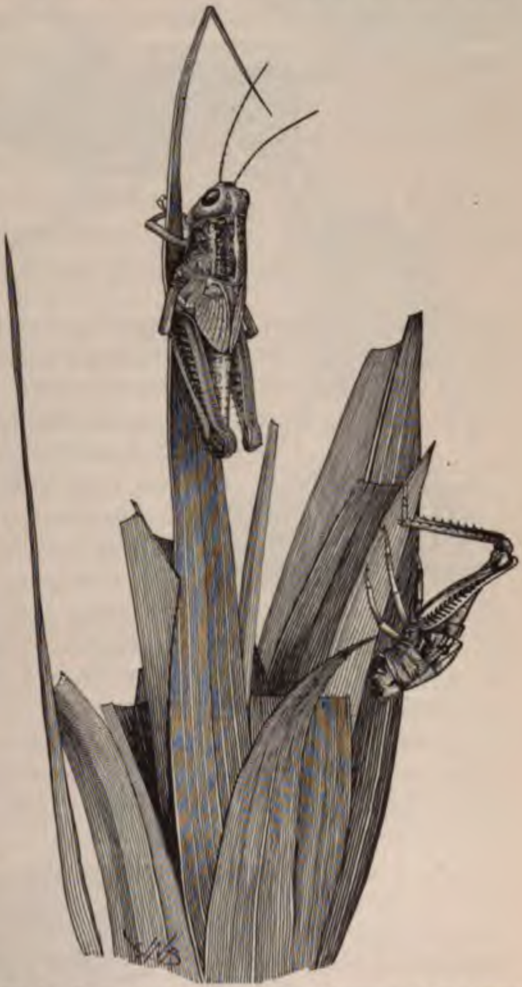


FIG. 6.—*Melanoplus differentialis* on corn leaves: adult in natural position, upper figure; pupa skin below on right—enlarged (original).

This outbreak, as well as the previous ones, was undoubtedly due to the large areas of uncultivated land in the river bottoms in 1903, as a result of the floods of the summer of 1902 and the spring of 1903. These uncultivated fields, grown up to rank weeds which are the favorite food of the grasshoppers and with a hard, baked soil, furnished an ideal place for them to multiply and in which to lay their eggs in the fall of 1903. From these fields and from uncultivated fence rows the young emerged in the spring of 1904, and in many cases it was difficult to successfully cope with them, owing to the fact that the fields from which they emerged remained uncultivated and in them nothing was done toward checking the pest.

The grasshoppers become full grown late in June, and the eggs are laid in the ground during August and September, usually in a firm, hard soil such as that described above. It is evident, therefore, that where large areas of land are left uncultivated and wide strips of uncultivated ground grown up in weeds surround the fields, an ideal place is furnished for the grasshoppers to multiply and oviposit; and being too numerous to subsist upon the vegetation there found, the young hatching from these eggs migrate to fields of cultivated crops.

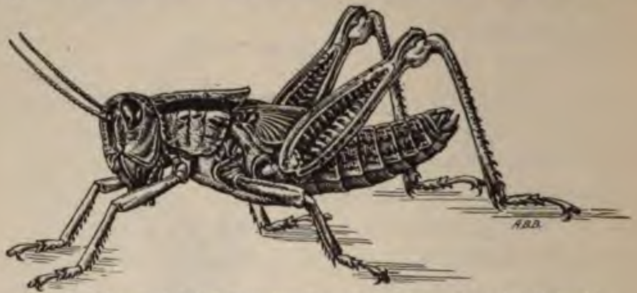


FIG. 7.—*Melanoplus differentialis:* young nymph—enlarged (original).

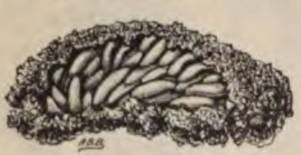


FIG. 8.—Egg mass of *Melanoplus differentialis*—enlarged (original).

It has been repeatedly demonstrated that the very best method of controlling such outbreaks is to thoroughly plow and harrow all land where the eggs are laid in the fall as soon as possible after they are deposited. If this be done serious injury will be rare, but if neglected the planter should be prepared to combat the young as soon as they hatch with the remedial measures above outlined, for they are by no means so easily or effectively poisoned when full grown or nearly so.

The large lubber grasshopper.—In southwestern and west-central Texas the large lubber grasshopper (*Brachystola magna* Gir.) (fig. 9) often occurs in large numbers and destroys fields of cotton, as it takes but a short time for one of these huge insects to ruin a plant. The chief damage is done late in May and in June and mostly to cotton, this crop seeming to be a favorite with them, though they are found in

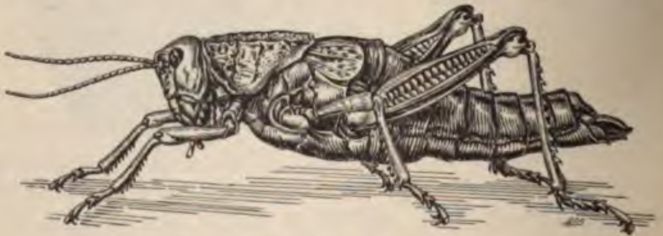


FIG. 9.—*Brachystola magna* (original).

pastures far away from farms. The habits of this species are not well known, but it seems probable that the grasshoppers deposit their eggs in grass land, as it is said that they are not injurious where hogs are allowed free range. They may be controlled by a liberal use of the poisoned bran mash above described, but it should be applied as soon as they appear.

WINGLESS MAY BEETLES.

Two species of wingless May beetles (*Lachnosterna lanceolata* Say and *L. cribrosa* Lec.) often seriously injure young cotton, as well as various other crops, especially garden truck, in the arable land west of the ninety-seventh meridian. Frequently they occur in immense numbers and cut off the young cotton plants over a large field. As they are wingless they may be readily caught by hand picking or they may be poisoned by dusting the plants and all weeds with Paris green.

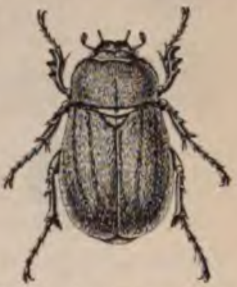


FIG. 10.—*Lachnosterna lanceolata:* female—somewhat enlarged (original).

The first of these species (fig. 10) is of a grayish tinge, and is more injurious in west-central counties than elsewhere, although it also occurs in northern Texas. It feeds upon careless weed (Amaranthus) and wild sunflower (Helianthus). *L. cribrosa* (fig. 11) has been reported from all parts of northwestern Texas as injurious to cotton and all sorts of garden stuff. It prefers the ragweed to all other food plants. A third species (*L. farcta* Lec.) is more common in the southwestern part of the State, where it has often been injurious. It has similar habits to the wingless species, but is usually provided with wings.

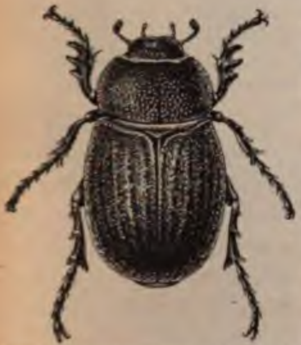


FIG. 11.—*Lachnosterna cribrosa:* female—enlarged (original).

The species have much in common, although the complete life histories and habits are not known. The last two species emerge from the soil—where they remain hidden during the day—about an hour before sundown and feed from then until dusk, when they return to the holes left or make new ones. Their globular, colorless eggs are laid in June about two inches deep in the soil, and the larvæ feed on the roots of various weeds and grasses but have never been observed as injurious. It has been noted that the beetles are the most injurious where a field has been allowed to grow up to weeds the previous summer, and that where the land has been plowed in the winter and cultivated in early spring they are by no means as abundant as usual.

INSECTS WHICH INJURE THE LEAVES.

The salt-marsh caterpillar (*Estigmene acræa* Dru.).—This is one of the so-called "woolly bear" caterpillars, being about two inches long, black, and covered with long black and red hairs. (See fig. 12.) The caterpillars have been reported as stripping cotton of its foliage in May at Paris, Tex., in 1885, and in July in southern Texas in 1903. The loose cocoon in which the larva transforms to the pupa is made among the leaves of the cotton or more often in rubbish on the ground. From these the moths emerge in about two weeks, the complete life cycle occupying about forty-five days. There are probably four broods in a year. These caterpillars have been reported to be unsusceptible to poisoning with Paris green when full grown, but like many others could probably be killed without difficulty if poisoned while still young.

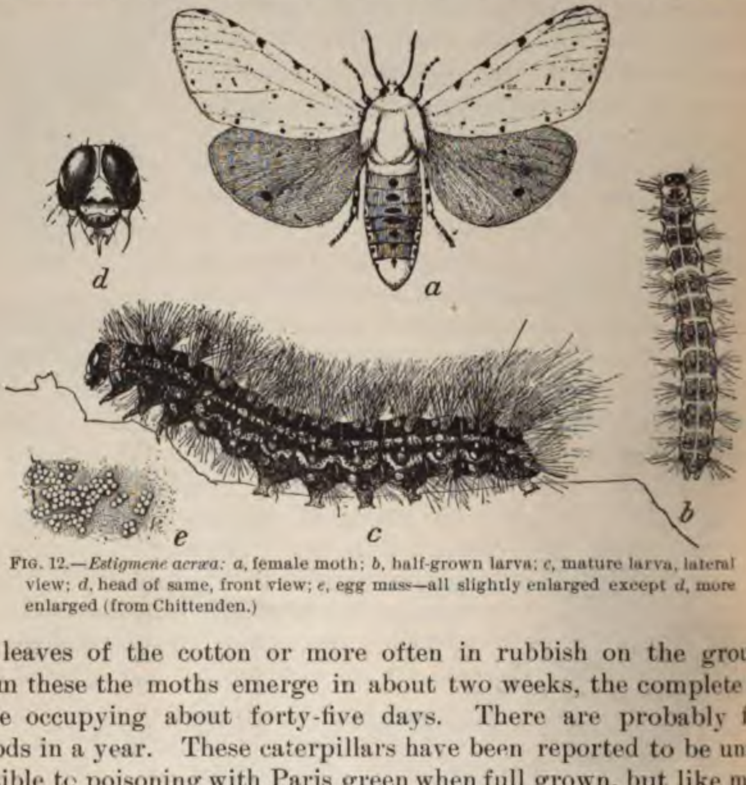


FIG. 12.—*Estigmene acræa*: *a*, female moth; *b*, half-grown larva; *c*, mature larva, lateral view; *d*, head of same, front view; *e*, egg mass—all slightly enlarged except *d*, more enlarged (from Chittenden.)

The arge tiger moth (*Apantesis arge* Dru.).—A similar caterpillar is common upon cotton, but has never been as injurious as is the salt-marsh caterpillar.

The beet army worm (*Caradrina exigua* Hbn.).—A small green caterpillar, about an inch long, which in Colorado and California has been a serious enemy to sugar beets and is known as the beet army worm.

›rthy of note on account of its past records elsewhere. It has found commonly in northern Texas feeding on cotton foliage eating into the squares. different stages are shown ;ure 13. It is readily coned by means of arsenicals.

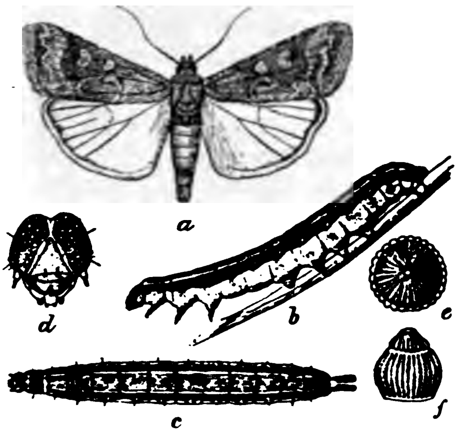


Fig. 13.—*Caradrina exigua:* a, moth; b, larva, lateral view; c, larva, dorsal view; d, head of larva; e, egg, viewed from above; f, egg, from side—all enlarged (e, f, after Hofmann; a–d, after Chittenden).

ıe fall army worm (*La-ma frugiperda* S. & A.).—asionally the larvæ of the army worm stray into the :on fields when they become essively abundant—in late nmer or early fall—and netimes do local injury to › foliage.

The Io moth (*Automeris io* ıb.).—The green, spine-cov·ed larvæ of this moth are not ncommon on cotton and will e easily recognized if handled, as the prick of the spines is poisonous.

The cotton-boll cutworm (*Prodenia ornithogalli* Guen.) (figs. 14 and 5).—Throughout the season the caterpillars of this so-called cutworm re found eating the foliage and boring into the squares and bolls ıuch as does the bollworm. But in habits they are quite different rom the true cutworms, feeding by day and not cutting off the stems f the young plants. The olive or greenish-brown caterpillars may

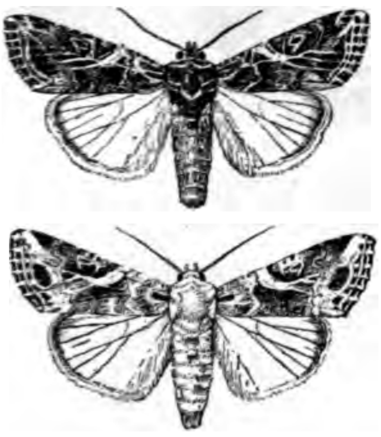


Fig. 14.—*Prodenia ornithogalli:* dark form, male, above; pale form, female, below—somewhat enlarged (from Chittenden).

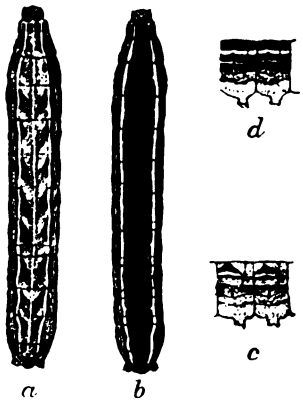


Fig. 15.—*Prodenia ornithogalli:* a, pale form of larva; b, dark form of same; c, lateral view of abdominal proleg segments of pale form; d, same of dark form—all enlarged (from Chittenden).

be readily recognized by the two rows of triangular, velvety-black spots extending down the back, as shown in figure 15. Four or five broods occur in a year in Texas. These caterpillars have never been reported as seriously injurious to cotton, but they often do considerable local damage to the squares and bolls. By picking them off of the young cotton when chopping in the spring, they may be largely controlled.

Leaf-cutting ant (*Œcodoma fervens* Say.).—Especially in southern Texas, cotton, as well as fruit trees and garden crops, often suffers from the devastations of the leaf-cutting ants, which cut off pieces of the leaves and carry them to their nests. Here they form the foundation upon which grows a fungus which is the food of the larvæ. These ants are one of the worst insect pests in the Tropics. Recently Prof. M. T. Cook, entomologist of the Cuban department of agriculture, has found that by sprinkling Paris green freely around the entrances of the nests the ants will carry it into the nests and the larvæ will be killed by it at slight expense. This promises to be the best means of controlling the ants where there are many nests, as in Cuba. The remedy which has been most used for this and ants with similar habits consists in injecting carbon bisulphid (locally known in Texas as "high life") and then closing the holes with earth. The heavy fumes will descend into the nest and destroy the occupants. The amount necessary will depend upon the size of the nest, as an individual nest is often quite large.

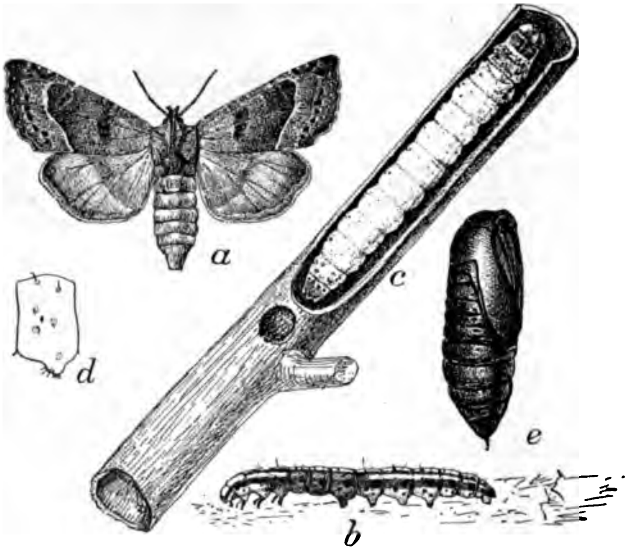


FIG. 16.—*Papaipema nitela*: *a*, female moth; *b*, half-grown larva; *c*, mature larva in injured stalk; *d*, lateral view of abdominal segment of same; *e*, pupa—all somewhat enlarged (from Chittenden).

INSECTS WHICH INJURE THE STALK.

A number of insects are frequently found boring into or otherwise injuring the stalks, but we know of no case in which the injury has been serious.

The stalk borer (*Papaipema nitela* Guen.) (fig. 16).—This insect, which is quite different from other common borers, being black, with white stripes in its early stages, has been noticed boring into the stems several inches above the ground and causing the plants to wilt. It commonly feeds in various weeds, most commonly in the so-called "bloodweed."

The small jet-black beetles of *Amphicerus fortis* Lec., nearly related to the apple twig-borer, are often found in considerable numbers in the old cotton stalks in the spring, but have never been noted as injuring the growing plants.

The cotton-stalk borer.—One of the long-horn beetles, *Ataxia crypta* Say, whose larvæ commonly bore in the stalks of the cocklebur, sometimes bores into cotton stalks otherwise injured, but is not known to injure healthy plants.

The snowy tree cricket (*Œcanthus niveus* DeG.).—Mention should be made of the eggs of this insect, which are deposited in the stalks of cotton and various common weeds in the fall, since they have been frequently thought to be eggs of the boll weevil. These eggs are laid in a long row, leaving a long scar, composed of numerous punctures on the surface. They are deposited in the fall after the cotton is about grown and do no harm, so far as we are aware. The young which hatch from them the following spring, as well as the adults, feed very largely upon plant-lice, and are therefore more beneficial than injurious.

INSECTS WHICH INJURE THE SQUARES AND BOLLS.

The cotton square-borer (*Uranotes melinus* Hbn.).—During late May and in June cotton squares are often bored into by a small green caterpillar which many planters consider a stage of the bollworm and others have called the "sharpshooter." Injury from this cause is often quite serious for a short time on a small area, as we have seen 10 per cent of the stalks entirely denuded of squares in small fields where this insect is abundant. The caterpillars hollow out the squares in the same manner as does the bollworm, often destroying all of those on a plant knee high and even boring into the stalk. They are bright green, oval, decidedly flattened, covered with short hairs which give them a velvety appearance, and with the head retracted under the front of the body, being quite unlike any stage of the bollworm. They are the larvæ of a dainty little butterfly (shown slightly enlarged in fig. 17) which is very common around cotton fields. The eggs are laid on the leaves and stems of cotton, cowpeas, goatweed and various weeds. The larvæ have also been commonly found on hops, beans, and cowpeas, and seem to prefer the latter to cotton.

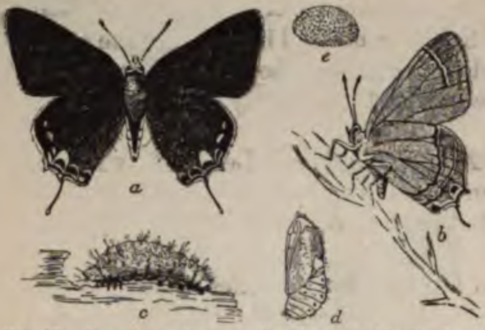


FIG. 17.—*Uranotes melinus:* *a*, dorsal view of butterfly; *b*, butterfly, with wings closed; *c*, larva from side; *d*, pupa; *e*, egg—all somewhat enlarged, except *e*, greatly enlarged (all except *e* redrawn from Howard).

Fortunately for the planter, the large majority of the caterpillars are usually parasitized by flies about the size of the housefly and also by small, wasp-like hymenopterous insects. The parasitic flies lay their eggs upon the caterpillar, and the maggots hatching from them bore into the caterpillar and feed upon its tissues, ultimately killing it and emerging from it or the pupa as adult flies. Over 90 per cent of the June brood have been found thus killed. It is usually hardly worth while, therefore, to attempt to combat this insect, as it is not often seriously injurious in the same locality year after year. Should remedial treatment be necessary, thorough dusting with Paris green would probably answer the purpose, as the young caterpillars, as do bollworms, feed to some extent upon the foliage before entering the squares.

Cotton "sharpshooters."—Every summer late in July and August frequent reports are made of considerable injury to cotton by "sharpshooters," especially on low land. These insects are reported to puncture the squares and bolls, causing them to drop prematurely, a small black speck showing the point where punctured.

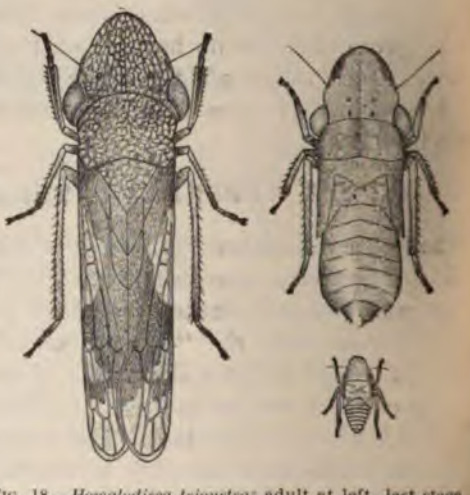


FIG 18.—*Homalodisca triquetra:* adult at left, last stage of nymph at right, young nymph below—all enlarged (original).

Very few planters, however, are able to identify the insect blamed for the trouble. The insect which has commonly been credited with this work is the glassy-winged sharpshooter (*Homalodisca triquetra*

), but with it are associated several near relatives with s—*Oncometopia undata* Fab. (fig. 19), *O. lateralis* Fab. *Aulacizes irrorata* Fab. (fig. 21). Many planters know as "dodgers," from their habit of quickly dodging to side of the stem ed, and those fa- hem have thought ss.

bservation during has failed to show o cotton done by s. Repeated ex- ith the insects in have failed to show ver puncture the olls. There seems slightest evidence ects are ever inju- ton, and the sup- y is undoubtedly ysiological condi- plant which, at the season when the supposed injury es a marked shedding of the fruit.

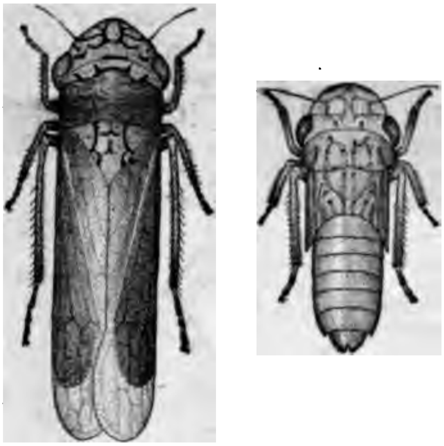
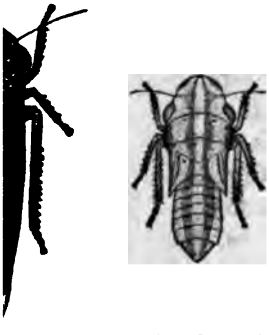


FIG. 19.—*Oncometopia undata:* adult at left, nymph at right—greatly enlarged (original).


opia lateralis: adult and nymph—ly enlarged (original).

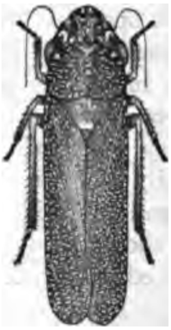


FIG. 21.—*Aulacizes irrorata:* adult—much enlarged (original).

The adult insects hibernate in rubbish on the ground near the food plants and appear in early spring on the elm, yaupon, hackberry, redbud, cottonwood, willow, and the tender shoots of other trees, especially on bottom land along the streams, where these ost common. Here they suck the juices er leaves and terminals and deposit their tender leaves and stems. The eggs are r of 10 to 15, side by side, just under the the leaf, forming a blister-like mark. in a few days and the young bugs feed in the same places parents. The young bugs, or nymphs, shown in figures re grayish or yellowish in color and resemble the adults except that they lack wings. Two or three annual generations occur in Texas. The insects are not usually common on cotton until midsummer, and even then are by no means as abundant as on the trees mentioned. They are exceedingly fond of banana trees, sorghum, and sunflowers, sometimes injuring the latter considerably. Records of any injury to cultivated crops by the glassy-winged sharpshooter, the most common species on cotton, are exceedingly rare and doubtful, and there is no evidence whatever for considering it an enemy to cotton.

The cotton leaf-bug (*Calocoris rapidus* Say).—This insect was the cause of considerable damage in northern Texas in August and September, 1904. It punctured the squares and young bolls, either causing them to drop, or making the bolls shrivel or decay where punctured. The punctures in the bolls are indicated by small round black spots resembling diseased places, which gradually become larger and sunken (fig. 23). This insect has been known as a common inhabitant of cotton fields for many years, but injury seems to have been rare. It may be readily recognized by the bright red spots just beyond the middle of the wing. The young are shown in figure 22, and are light green marked with red. Several annual generations of the insect occur, but its habits outside of the cotton field are unknown. No successful means of combating it has yet been devised.

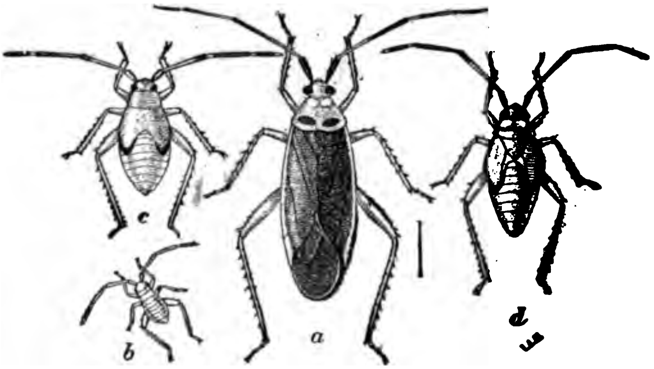


FIG. 22.—Cotton leaf-bug, *Calocoris rapidus*: *a*, mature bug; *b*, young nymph; *c*, fourth stage of nymph; *d*, fifth stage of young (original).

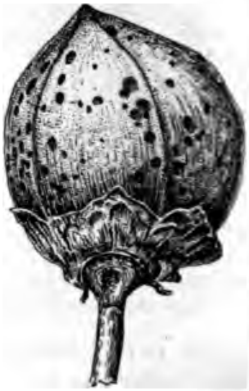


FIG. 23.—Cotton boll showing punctures of *Calocoris rapidus* (original).

Other plant-bugs.—Similar injury to bolls, causing black spots and shrinking or decay, is caused by the large green plant bugs variously known as "pumpkin bugs," "stink bugs"—from the very disagreeable odor emitted—and by other local names.

most common of these is *Nezara hilaris* Say, shown in figure 24. bright green in color, and is undoubtedly a decidedly injurious ct, as it has been known to attack orange trees in Florida and awberries and r garden crops where.

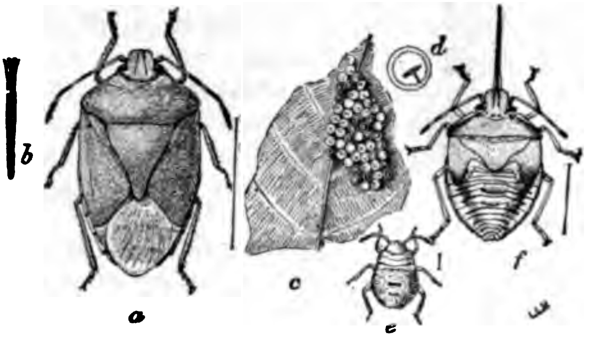


FIG. 24.—*Nezara hilaris*: *a*, mature bug; *b*, beak of same; *c*, egg mass; *d*, single egg; *e*, young nymph; *f*, last stage of nymph—all enlarged; *b*, *d*, more enlarged (from Chittenden, unpublished).

he leaf-footed t-bugs (*Lepto- ssus phyllopus* n. and *L. opposi-* Say) (figs. 25 and injure the bolls he same manner. se insects are also ous enemies of ches and toma- s in Texas. They ed commonly on thistles and should be destroyed wherever found. wo other bugs somewhat resembling the so-called "cotton stainer," ugh of a slaty or bluish color, margined with yellow or red, *Largus*

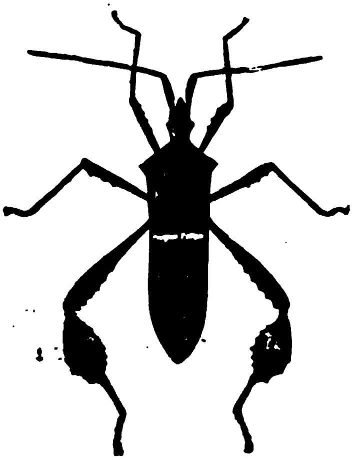


FIG. 25.—*Leptoglossus phyllopus*, twice natural size (after Hubbard).

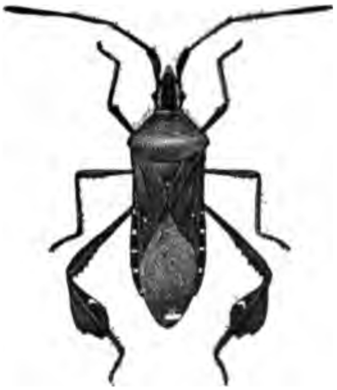


FIG. 26.—*Leptoglossus oppositus*—twice natural size (from Chittenden.)

cinctus Linn. and *Jadera hæmatoloma* H.-Schf., are frequently und in considerable numbers on the bolls and do some damage. e young nymphs feed upon low-growing weeds and have not been served on cotton. There is no evidence of any injury in Texas by e so-called "cotton stainer" (*Dysdercus suturellus* H.-Schf.).

Click-beetle.—A small species of click-beetle (*Monocrepidius vesper- inus* Fab.), shown in figure 27, is frequently found on cotton blossoms and squares and working around holes made by the bollworm or square borer. It is of interest because frequently mistaken for the boll weevil where that insect is not well known. There is some evidence that these beetles sometimes eat into a square, but if so, the injury is rare and inconsequential.

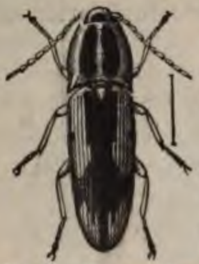


FIG. 27.—*Monocrepidius vespertinus*—enlarged (from Chittenden).

The cowpea-pod weevil (*Chalcodermus æneus* Boh.) (fig. 28).—This is commonly an enemy of cowpea, working in the pods and seeds of the developing peas, but has been observed eating into the stems of young cotton plants and sometimes attacking the young squares in Texas, Louisiana, and Georgia, the injury being more severe in the latter State, where cowpeas are more commonly raised. It is frequently mistaken for the boll weevil.

Bruchus amicus Horn.—This small gray beetle, which quite closely resembles the pea weevil, has been observed upon cotton squares in southwestern Texas and was thought to be injurious, but was probably merely feeding upon nectar, as it breeds in the pods of the mesquite.

Acorn weevils.—Various species of acorn weevils (*Balaninus* spp.) are frequently found on cotton, especially near woods, and may occasionally be seen feeding on squares. They never do material injury, but may easily be mistaken for the boll weevil by those unacquainted with the latter pest.

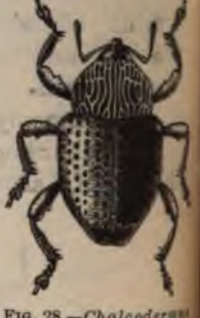


FIG. 28.—*Chalcoderm* *æneus*—enlarged (fr Chittenden).

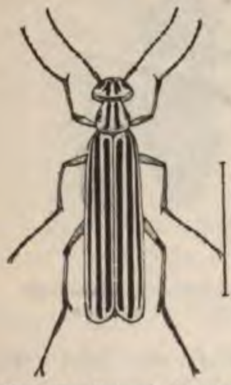


FIG. 29.—*Epicauta lemniscata*—enlarged (from Chittenden).

Blister beetles.—Blister beetles of various species (*Epicauta vittata* Fab., *E. lemniscata* Fab. (fig. 29), *E. cinerea* Forst., and *E. ferruginea* Say) are frequently found eating holes in the cotton flowers, but never in sufficient numbers to cause material injury.

A large number of common insects are found upon the cotton plant, some frequenting it habitually and others merely accidentally, but the above are the only ones observed as injurious in Texas in recent years.

CONCLUSION.

It will have been observed that most of the common insect enemies of cotton above described naturally feed upon various common weeds which grow up in neglected or uncultivated fields, and that, by the destruction of such weeds, and winter plowing where they have grown, the insects inhabiting them will be largely controlled. The thorough cultivation, during the late fall, winter, and early spring, of all land to be planted, or which has been infested, will also be the means of greatly reducing their numbers by killing many of the stages then hibernating in the soil. These two general principles must be relied upon to a large extent for the control of most of the minor cotton insects. When they become overabundant those leaf-eaters which chew their food may be poisoned with Paris green or other arsenicals, used as a dust or made into a mash with bran.

More intensive cultivation will undoubtedly result in a material lessening of injury by these pests, for in the eastern cotton-growing States they are by no means as injurious as in Texas, so far as the records indicate. The better methods of cotton culture generally recommended by this Department during the past few years will undoubtedly result in the lessening of injury by all the more common cotton insects.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, show
the number and title of each. Copies will be sent to any address on applicatio
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culture, Washington, D. C.:

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Swine Plague. No. 25. Peanuts: Culture and Uses. No. 27. Flax for Seedand Fiber. No. 28. W
And How to Kill Them. No. 29. Souring and Other Changes in Milk. No. 30. Grape Disease
the Pacific Coast. No. 31. Alfalfa, or Lucern. No. 32. Silos and Silage. No. 33. Peach Growing
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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 224.

ANADIAN FIELD PEAS.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., April 6, 1905.

Sir: I have the honor to transmit herewith the manuscript of an article Canadian Field Peas, being a revision and extension of an article on this subj which appeared in the Yearbook of this Department for 1895, and recomme its publication as a Farmers' Bulletin.

This paper was written by Mr. Thomas Shaw, formerly Professor of Anin Husbandry in the College of Agriculture of the University of Minnesota, a was submitted by the Agrostologist with a view to publication.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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CANADIAN FIELD PEAS.

INTRODUCTION.

The term Canadian field peas, or, as it is more commonly expressed, Canada field peas," is used with much latitude in this country. sk a pea grower in the United States as to the variety of seed hich he sowed and e almost invariable nswer given is: "I wed Canada peas." hat may mean that e grew any one of early one hundred arieties. The anwer is significant. t implies, first, a reat lack of knowldge with reference o varieties on the art of those who row peas; and, secnd, that much of he seed used in the Jnited States is, or vas at one time, imorted from Canada, lthough we have arge areas unrivaled n their adaptability o the growing of peas. common type of the anadian field pea is hown in figure 1.

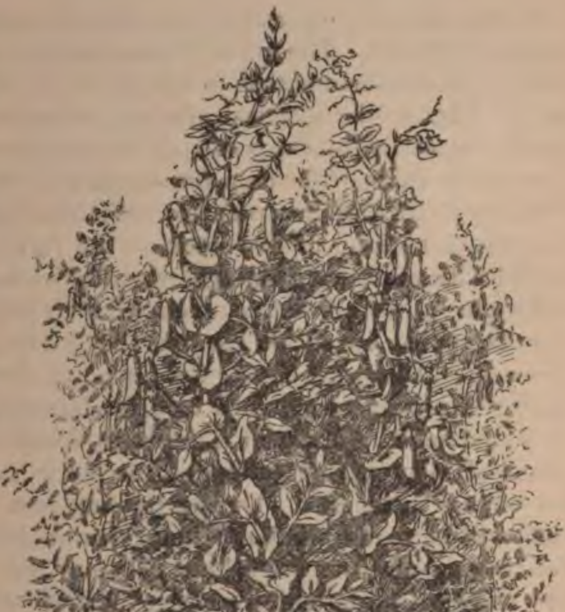

FIG. 1.—The Canadian field pea.

The pea crop is one of the most important in Canada. In the Provice of Ontario alone the average area devoted to the production of eas for the twenty years ended with 1902 was 710,498 acres. The average annual yield during the period named was 13,770,243 bushels, or an average of 19.4 bushels per acre. The greater portion of this crop is fed upon Ontario farms.

In striking contrast with the magnitude of the pea crop in Canada is its insignificance in our own country. While the area devoted to peas in Ontario until quite recently was not far behind that devoted to winter wheat, the pea crop in this country is so insignificant, relatively, that it has not been given a fixed place in the Government crop reports. In Minnesota it is not mentioned in the yearbook of statistical returns, and the same seems to be true of nearly all the States in the Union. Great advances, however, have been made during recent years in growing peas in Michigan, Wisconsin, and Montana, and other mountain States.

VARIOUS USES OF THE PEA CROP.

No other grain crop, except perhaps oats, can be devoted to so great a variety of uses. The grain is possessed of a relatively high feeding value, and the same is true of the straw, as will be readily apparent by reference to the chemical analysis of each. As a pasture for certain kinds of live stock, peas may be made to serve an excellent purpose. The value of the crop for soiling and fodder uses is very great, and as a fertilizing crop peas are probably excelled only by clover.

There is no kind of live stock on the farm to which peas can not be fed with positive advantage, when they are to be had at prices not too high. They are not commonly fed to horses, since they can seldom be spared for such a use, but they make a good food for horses at work, and for colts during the period of development, if given as a part of the grain food. As a food for fattening cattle, peas are probably unexcelled. Much of the success which Canadian feeders have achieved in preparing cattle for the block has arisen from the free use of peas in the diet. During the first part of the finishing period they will be found peculiarly helpful in making beef, owing to their relative richness in protein, but they are also a satisfactory food at any stage of the fattening process. During the first half of the finishing period peas will be found superior to corn, but toward the close of the same, corn could probably be fed with greater relative advantage. Peas with oats or wheat bran make an excellent grain food for cattle that are being fattened. Speaking in a general way, peas should form about one-third, by weight, of the meal fed, but, as every feeder knows, the relative proportions of the meal used should vary somewhat as the season of fattening progresses.

As food for milch cows.—Peas furnish a good food for milch cows. They have been found peculiarly beneficial for building up dairy cows when "out of condition," and for sustaining them in fine form, and they are also excellent for milk production. When given along with oats and bran to cows in milk, they may usually form from one-third to one-half of the grain portion by weight.

As food for swine.—Peas, when fed with judgment and care, supply an excellent food for swine at all stages of development. They are well adapted to the sustenance of brood sows during the nursing period, for the reasons that have been given for their use with cows giving milk. With shorts, ground oats, or wheat bran, they may be made to form one-third to one-half the grain portion. Peas are superior to corn as a food for pigs at any time prior to the fattening season; hence they may be fed to them more freely, but in no instance should they form the sole ration before the finishing period begins. During the fattening period peas are unexcelled when fed as the sole grain food. They promote growth, while they fatten in excellent form, and they furnish a sweet, firm, and excellent quality of pork.

As a ration for ewes and lambs.—Along with oats, in, say, equal parts by weight, peas make a good grain ration for ewes in milk, and also lambs, more especially when the latter are for the early market. They may be used in greater proportion to fatten ewes quickly after the lambs have been weaned. When sheep are being fattened for the block in winter, no grain food can be fed which will be found more suitable than peas and oats. When fed to sheep or poultry, or to brood sows in winter, peas do not require to be ground. For all other live stock it is considered advantageous to grind them, but in some instances they are soaked for feeding to swine. When so prepared they are frequently fed to growing swine when on pasture, and in order to insure due mastication they should be fed on a floor.

As food for horses, cattle, and sheep.—When pea straw is well cured, it is more relished by horses, cattle, and sheep than the straw of rye, wheat, barley, or even oats. Animals which have never eaten it may not take kindly to it at first, but soon learn to eat it with a relish. The value of the straw, however, depends largely upon the stage at which the crop is harvested, the mode of harvesting, and the perfection of the curing process. Pea straw harvested rather underripe than overripe, and then properly cured, will be eaten readily, but when allowed to get dead ripe, live stock will eat little of it unless compelled to do so by hunger. If harvested with the old-fashioned revolving horserake, so much of the soil adheres to the straw that it is not relished by any class of live stock; and when rain falls upon the straw while it is curing, it becomes bleached and loses much in palatability. Two or three smart showers falling upon pea straw greatly injure it. When cut with the scythe or the pea harvester, cured properly, then housed or carefully stacked, the straw, except that of some of the coarsest varieties, is nearly equal to clover hay in feeding value, especially for sheep.

As pasture for sheep.—Peas are more commonly used as a pasture when sown in conjunction with some other kind of grain, and since they are more easily injured by the trampling of live stock than other grain crops, it is usual to pasture them only with sheep and swine. When sown with oats or barley, peas make a good summer pasture for sheep. The greatest objection to such pasture is in the earliness of the season at which it is produced. Of course, it may be grown later, but will not produce so abundantly. One-fourth of an acre grown at the Minnesota Agricultural Experiment Station in the spring of 1895, under the supervision of the writer, furnished pasture sufficient for one sheep for 345¾ days. The pasture was eaten down three times successively, with a suitable interval between the seasons of pasturing. The plat was then sown with rape, and this in turn was pastured off. The great value of peas as a pasture for swine is far too little understood.

As a soiling crop.—Peas grown in conjunction with some other kinds of grain are of great value as a soiling crop, owing, first, to the larger yields obtained (from 10 to 20 tons per acre may be expected on average soils); second, to the high nutritive value of the food, combined with its palatability; and, third, because of its timeliness. This crop is ready as soon as the spring grasses begin to fail, and it may be made to continue in season until corn is ready. It is excellent for all kinds of live stock, but especially valuable for dairy cows.

The advantages resulting from growing peas in conjunction with other grains for fodder are many. They include the following: First, larger yields may be obtained from growing these mixtures than by growing the grains used in them singly, and the increased yield extends to the grain as well as to the straw; second, when fodder is thus grown it may be fed directly to the animals—it is not necessary, usually, to chaff it with the cutting box, and the labor and cost of first thrashing and grinding the grain are avoided; third, a pasture crop, such as rape or rye, may follow the same season. Such a system will be found most helpful as an aid in destroying weeds. As the relative areas adapted to growing these foods far exceed those adapted to growing peas for the grain, it is probable that in the near future they will be most extensively grown for soiling and fodder uses.

As a nitrogen gatherer.—Like all leguminous crops, peas have the power of extracting nitrogen from the air and of depositing it in the soil for the use of other crops which follow. Hence it is that the soil on which a crop of peas has been harvested is richer in nitrogen than before the peas were sown upon it. In this we have one explanation of the practice which became general in Ontario of following peas with winter wheat. Peas could thus be made to bring more nitrogen to the soils of this country every year than is now purchased annually by the farmers at a cost of millions of dollars.

As a green manure.—Besides the nitrogen that it brings to the soil, the value of a crop of peas in fertilizing and also in improving the mechanical texture of the soil is greatly enhanced when it is grown as a green manure. When soils become so impoverished that good crops can no longer be grown on them, they may be quickly renovated and also cleaned by plowing under a pea crop preceded by winter rye. The rye should, of course, be sown in the autumn, and plowed under in the spring when the heads begin to appear. The peas should be sown immediately, and in turn plowed under when in bloom. Ground thus treated would be fertilized and cleaned in one season. Its tilth would be much improved, and its power to hold moisture would be greatly increased. To a farmer in the dry Northwest the benefit last mentioned would probably be the greatest. The high price of the seed in the past has stood seriously in the way of growing peas expressly for fertilizing uses.

WHY THE PEA CROP HAS BEEN NEGLECTED.

That so valuable a crop should not have received more attention is indeed surprising. Chief among the reasons why it has been so neglected are the following: The lack of knowledge as to its merits, the difficulty in procuring seed, the want of suitable machinery for harvesting the crop, and the small measure of attention given to it, relatively, by the experiment stations. But little is known of the value of the pea crop by the average farmer.

The scarcity and costliness of seed have hindered many from growing peas. The average prices paid to seedsmen in the United States during recent years for good, clean seed have been from $1 to $1.50 per bushel. The Ontario farmer usually raises his own seed or buys if for about 1 cent per pound. Suppose a farmer should buy but 1 bushel of seed and sow it with care; he may expect in the autumn 10 to 25 bushels of seed wherever the conditions are favorable to growing the crop. In some of the mountain States 40 bushels per acre are frequently harvested. Why should not farmers generally raise their own seed peas?

The lack of suitable machinery for harvesting peas has probably more than anything else hindered the extension of their growth in the United States. Where peas have to be harvested with the scythe, they are not likely to be grown to any considerable extent; but, as shown elsewhere, pea harvesters are now in use in Ontario which will cut a field of peas as quickly as a field of hay of equal area.

Very little attention relatively has been given to this crop by the experiment stations of the continent, with two or three exceptions. But little that can be regarded as of much value to the farmer is to be gleaned from station reports. The Ontario station, at Guelph, is an exception. The writer, when in charge of that station, imported many varieties from Europe and other countries for experimental uses, and the cooperative experiments with the best of these varieties which have since that time been carried on by the farmers in various parts of Ontario have been of great value in determining the most suitable kinds for the different sections of the country. In the judgment of the writer, experiments conducted on somewhat similar lines by experiment stations located in some, if not, indeed, in all the Northwestern States, would render most valuable service to these States.

AREAS ADAPTED TO PEA CULTURE IN THE UNITED STATES.

Without any doubt there are vast areas in our favored country well adapted to growing peas as a grain crop. But the areas in which the crop can be grown for pasture, for soiling uses, and for fodder are vastly greater, as heretofore intimated; for where peas can be successfully grown as a grain crop they can also be grown for the other uses named. In the present state of our knowledge it would be impossible to enumerate all the areas in which peas can be successfully grown for any of the uses mentioned, and it would be even more hazardous to specify where they can not be grown. But these areas may be defined in a general way.

Peas can be grown as a grain crop with a reasonable degree of success in certain areas of New England and in much of New York and Pennsylvania. They are successfully grown in northern Michigan, northern and eastern Wisconsin, and northern Minnesota. They will also grow well in North Dakota, Montana, Idaho, Oregon, Washington, and indeed in all the mountain States in which the elevation is sufficient to insure reasonably cool summer temperatures and where a reasonable amount of moisture is present. In northern Ohio, southern Michigan, southern Wisconsin, southern Minnesota, and South Dakota they are not so sure a crop as in the areas named, but sometimes they produce well.

Southward from the States just named, peas can not always be depended on to yield well. The summer temperatures are too warm for them. Even though they should produce a good crop of straw, if a hot wave should pass over them while in bloom they would not fruit well. But in all this section of country great use can be made of peas when grown with other crops for pasture, for summer feeding, and for fodder. Still farther to the south the wisdom of giving much attention to this crop is open to question; the southern cowpea has taken its place there.

GROWING PEAS FOR DIFFERENT PURPOSES.

In discussing the growing of peas as a grain crop, problems relating to soils, rotation, tillage, seed, varieties, harvesting, storing, and thrashing require to be considered.

ADAPTABILITY IN SOILS.

Peas may be grown successfully on a variety of soils, but those designated clay loams, and which are well supplied with lime, are best adapted to their growth. However, good crops may be obtained on the stiffest clays. The potash element in these favors the growth of peas. Light, leachy sands, being deficient in moisture, do not produce enough growth of vine, and black, humous soils produce too much. Overwet soils are wholly unsuited to the growth of peas.

PLACE IN THE ROTATION.

Theoretically, peas should not come after meadow or pasture, since they are capable of gathering nitrogen from the atmosphere, and in consequence do not need the sustenance furnished in the decay of grass roots so much as other grains; but in practice they serve the end of quickly subduing such soils by promoting the rapid decay of the sod and so putting the land in excellent condition for the crop which follows. Peas may be assigned any place in the rotation, but the aim should be to have a grain crop follow which is hungry for nitrogen.

PREPARING THE LAND.

In climates where peas can be grown at their best, namely, climates with low winter temperatures, the land for peas, as for nearly all grain crops, should be plowed in the autumn; but peas will do better than the other small cereals, relatively, on spring-plowed land. A fine pulverization of the soil is advantageous, but it is not so necessary for peas as for other grain crops, since the pea is a hardy and vigorous grower.

SOWING THE SEED.

Some writers advocate sowing the seed broadcast and then plowing it under. On heavy soils this method would bury the seed too deeply. On prairie soils it promotes the rapid evaporation of soil moisture. On fall-plowed lands the better plan is to prepare the seed bed by pulverizing it, and then to sow the seed with a grain drill. When broadcasted and covered with the harrow only and rain follows, much of the seed will be exposed; but the writer has grown excellent crops on spring-plowed stiff clays from hand sowing without any previous pulverization. When such lands are carefully plowed, the peas fall in the depression between the furrow slices, and the subsequent harrowing covers them. Peas should be buried less deeply on stiff clays and more deeply on the soils of the prairie. The depth may be varied from 2 to 5 inches. The pea crop should be sown as soon as the soil can be worked freely; but it will suffer less, relatively, than the other grain crops if the sowing has to be deferred.

The quantity of seed required will vary with the character and condition of the soil and with the variety of seed sown. Rich and moist soils do not require so much seed as where the opposite conditions prevail. The amount of the seed sown should usually increase with the size of the pea. The quantities to sow per acre will vary from 2 bushels with the smaller varieties to 3½ bushels of the larger sorts. One great difficulty to be encountered in growing peas on prairie soils is the usual luxuriance of weed life, but this may be held in check by harrowing the crop before it appears above the surface. Harrows with teeth which may be set aslant are the most suitable for the work.

VARIETIES TO SOW.

The most suitable varieties of peas to sow will depend somewhat on soil and climatic conditions; and the best way, probably, to determine which kinds are best suited to the varied conditions of each State would be through experimentation on what may be termed the cooperative plan, as practiced in Ontario. This plan in outline is as follows: The station furnishes the seed of a number of proved varieties to farmers in different sections of the country. These varieties are to be grown under similar conditions, and the growers are also to report the results to the station at a given date. The results are then summarized and made public. The farmer as his compensation keeps the grain which he grows.

Several varieties have been thus tested in Ontario for several years past. The three which have proved most satisfactory, all things considered, are the Prussian Blue, Canadian Beauty, and Tall White Marrowfat. The respective average yields of grain and also of straw have not been far different, nor was there much difference in the average time of maturing. The Prussian Blue is one of the most hardy, prolific, and reliable sorts grown in Ontario. The peas are blue in color and they weigh well. The Canadian Beauty is a handsome pea, white in color, and somewhat large in size. The Tall White Marrowfat is of large size and it is a vigorous grower. The four best yielding varieties grown at the Ontario experiment station for several years proved to be the Early Britain, White Wonder, Mummy, and Prussian Blue. The average yields were very similar. The Early Britain, imported from England in 1889, has proved a uniformly good yielder, but the peas are a little brownish in color and somewhat irregular in shape. The White Wonder, imported from New Zealand in 1890, is a very promising variety. It is a free grower, a good yielder, and the pea itself is attractive in appearance. The Mummy, a well-established variety, is a strong grower, but the straw is coarse. The pods are prone to cluster about the top of the vines. Among the other useful varieties that have been grown at the Ontario station are the Centennial White, Cleveland Advancer, and the Golden Vine. The last named is an old stand-by. When farmers speak of "Canada peas" they have reference probably to this variety more often than to any other. All the varieties named should do at least fairly well in the New England States, in northern Michigan and Wisconsin, and in the various western mountain States. Through the various States of the Northwest the following varieties stand high in favor with the farmer, namely, the Golden Vine, the Yellow Canada field pea, the Green Canada field pea, and, to a less extent, the Chancellor. It is not possible, however, to give the names of the most popular varieties in the Northwest with sufficient exactness, owing to the various names applied to the same variety.

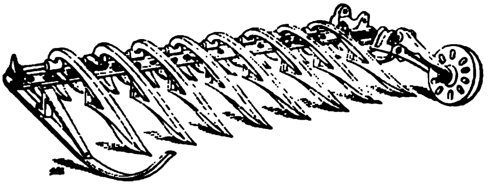

FIG. 2.—Pea harvester.

HARVESTING THE CROP.

Until recent years the pea crop was harvested with the scythe or with the old-fashioned revolving hayrake. The first method is slow; the second shells out many of the peas, and it so covers the vines with soil as to render the straw practically unfit for use. Happily, a pea harvester has been introduced, by the aid of which the crop may be harvested speedily and in excellent condition on level soils. It is simply an attachment to an ordinary field mower, as shown in figure 2.

The guards in front lift up the peas so that the knife can cut them cleanly. The cut peas fall behind the mower in a string-like row, or swath, and two men with forks bunch them and lay them aside out of the way of the horses. Three men and a span of horses may thus harvest 10 acres in a day. This attachment for harvesting peas is made in Canada, and those now in use in the West have all been imported. On rear-cut mowers a platform is sometimes used, as shown in figure 3.

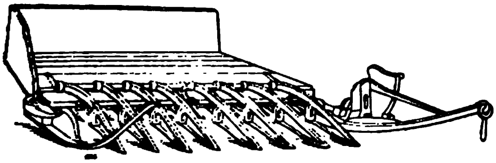

FIG. 3.—Pea harvester with platform.

With this attachment, one man walks behind and with a fork throws the peas off in bunches. But the platform is of doubtful advantage unless the crop is evenly ripened, not too heavy, and free from standing weeds of strong growth. Where the land has been plowed in ridges, with furrows more or less deep between them, the working of the machine will be seriously interfered with.

STORING THE CROP.

It is usual to turn the bundles over once to facilitate drying while they lie on the ground. They require hand loading. The crop may be stored under cover or put into stacks, as with other grain, but it should be borne in mind that peas when in the stack do not readily shed rain, and therefore the stacks should be carefully topped out with some substance, such as bluegrass or native prairie hay. When the thrashed straw is preserved in stacks the same precautions are necessary.

THRASHING THE CROP.

Where only a small quantity is grown annually, and this with a view to provide seed to sow for pasture, soiling, or fodder uses, there is no better way of thrashing the peas than by using a flail or by treading them out with horses. The seed is not then broken. Where a large acreage is grown it is necessary to thrash peas with a thrashing machine, and the best work is done by using the "bar concave," as shown in figure 4. From this concave all the teeth should be removed except four. These hold the straw in check long enough to enable the cylinder teeth to beat out all the peas. The machine should not run at a high rate of speed. More or less of the seed is likely to be broken. The broken grains, however, may be nearly all removed when preparing the crop for seed or for market by using fanning mills suitably equipped with sieves. When the crop is wanted for feeding uses the breaking of the peas does not, of course, lessen its value.

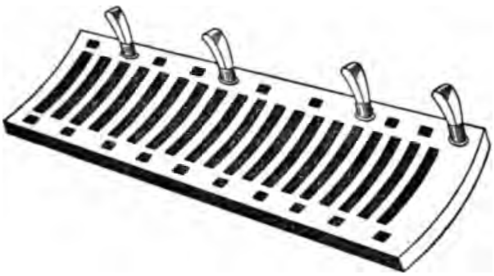
FIG. 4.—Single concave thrashing machine with four teeth.

HOW THE PEAS ARE GROWN.

The great value of peas for various uses has already been dwelt upon, and the method of growing and harvesting the grain crop has been discussed. It only remains, therefore, to speak of the methods by which peas are grown for ordinary grazing and soiling, for fattening sheep and lambs, and for fattening swine.

HOW GROWN FOR ORDINARY GRAZING AND SOILING.

When peas are grown in conjunction with other grain for pasture, the mixture should be sown somewhat thickly. For sheep, 1 bushel of peas may be taken as the basis of the mixture, and from 1½ to

2 bushels of other grain. When seed drills are used, the seed should be mixed before it is sown. Under other conditions it would be necessary to plow the peas in lightly, and then sow the other grain and cover it with a harrow. Peas and oats or peas and barley may be grown as a pasture for swine in the same manner as for sheep, but it is generally thought better to reduce the proportion of peas when the pasturing is to begin at an early stage in the growth of the plants, as swine break down the pea vines to a greater extent than sheep. Hitherto it has been common to sow peas alone as a pasture for swine, and to defer pasturing them until the peas in the pod are about ready for table use. About 2 bushels of seed per acre will suffice. Swine should be accustomed to such pastures by degrees, because the sudden change of diet might be injurious to them. The season of pasturing may be prolonged by sowing the peas at successive periods, with a proper interval between them.

When peas are grown as a soiling crop, the relative amounts of seed used on clay soils are much the same as when they are sown to provide pasture for sheep, and they are also sown in the same way. Oats, however, is the favorite grain to mix with the peas, and the proportions of seed used per acre on such soils are usually 1½ bushels of the former to 1 bushel of the latter; but no definite rule can be laid down as to the relative amounts of seed that should be used when growing these mixtures for soiling or for fodder uses. The richer the land the larger the proportion of peas that should be used, lest the oats should unduly overshadow them. On some of the humous soils of western prairies it may be advisable to sow not more than 2 to 3 pecks of oats per acre. Every farmer will have to determine for himself the relative quantities of seed which will best suit his conditions.

The cutting and feeding of the crop may commence as soon as the heads of the oats begin to appear, and it may be continued until the crop is approaching maturity. When not all wanted for soiling uses, the residue may be cut and cured for winter feeding. Generally the best yields will be obtained from the seed sown earliest in the season.

For winter feeding the same methods of growing peas may be adopted as when they are grown for soiling uses, with the difference that more varieties are frequently used. The harvesting should take place when the dominant grain used in the mixture is nearly but not quite ripe. When the respective quantities of seed have been correctly adjusted, the crop can be harvested with a binder in a normal season, but in case it is thrown down by storms a mower will have to be used.

HOW GROWN FOR FATTENING SHEEP.

During recent years a large area of peas has been grown in the San Luis Valley, Colorado, on which sheep and lambs—particularly the latter—are being fattened without harvesting the crop. In other words, the peas are harvested by the sheep. This valley has an elevation of 7,000 feet above the sea and the season for growth in it is very short. The temperature is so cool, especially after nightfall, that light frosts occur some seasons during every month of the summer. Peas were sown for a time in the valley to furnish hay, but now they are grown almost exclusively to furnish material for fattening sheep. In 1901, 15,000 sheep and lambs were thus fattened in the valley. On the crop of 1904 it is estimated that 200,000 have thus been made ready for the market. It is further estimated that this valley has a capacity for fattening 1,000,000 head annually. It is more than probable that the entire valley will be virtually devoted to the growing of peas within the next few years.

The peas are sown in the early spring on ground prepared by plowing or disking. The varieties sown are known locally as the Mexican and the Canada field pea. The former is more early in maturing than the latter. The peas are sown with an ordinary grain drill and from 40 to 50 pounds are sown per acre, along with a small quantity of wheat or oats. These are sown chiefly to furnish support to the pea crop, and the seed is mixed before sowing. Sometimes one irrigation is given, but more commonly the crop is not irrigated. The unirrigated crops receive moisture chiefly from subterranean sources, as the water table under much of the area of the valley is not far from the surface.

Sheep and lambs are brought in from the ranges and turned in to graze upon the crop as soon as it is ripe. The vine and grain are thus consumed where they grew. From seventy to ninety days will suffice to put lambs in the finest possible condition for the market. A somewhat longer period is required for ewes that are lean when first turned in to graze. Lambs will make about 8 pounds of increase per month while thus being grazed, and a good crop of peas will fatten from 10 to 15 lambs per acre. Assuming that each acre will graze 12 lambs on an average for ninety days, and that the increase made is worth 4½ cents per pound in Colorado, the value of the mutton thus produced on 1 acre would be $12.96. There would also be a further return from the increase in value of each pound of the weight of the lambs at the beginning of the grazing season. Though some of the peas are shelled out during the early stages of the pasturing, these are nearly all gathered later. The results are also more satisfactory when the sheep are made to graze down the crop by confining them to a portion of the area until it is consumed, rather than to allow them to roam over the entire area from the first. This can be done without difficulty by the use of movable fences.

In no other way can sheep and lambs be fitted for the market at so small an outlay, except by finishing them on Dwarf Essex rape. Finishing on rape is sometimes attended with loss from bloating, but this danger is not present when finishing on peas. The pea, being a nitrogen gatherer, leaves the ground in better condition as to fertility than rape; hence, where the conditions are suitable, it is without a rival, all things considered, in preparing sheep for the market. The favorable conditions are a suitable loam soil such as is usually found in the western valleys, an altitude sufficient to furnish a cool summer climate, ground moisture in sufficient quantity and near enough the surface to sustain the crop, or, in its absence, irrigating waters, and a dry season in which to graze down the crop. While all these conditions are important, that named last is indispensable, as to attempt to feed off a crop by sheep in rainy weather would result in an almost total waste of the crop and in disaster to the sheep.

The extent to which this system of grazing sheep may be extended in the mountain States is virtually without limit. It has been stated that the San Luis Valley has capacity to fatten 1,000,000 lambs each year. It is claimed that Colorado has several valleys each of which has nearly equal capacity and similar adaptation, to say nothing of the many smaller ones scattered through the State. This is doubtless also true of each of the States of Wyoming, Montana, Idaho, Utah, Nevada, and of California, Oregon, and Washington. The expectation, therefore, would not seem extravagant that the industry will extend to all these States in the near future and that it will eventually absorb all the surplus sheep and lambs grown on the western ranges to supply its needs. Such a result would be simply beneficent. It would revolutionize sheep husbandry in the West.

HOW GROWN FOR FATTENING SWINE.

In some of the Northwestern States, and in all the valleys of the western mountain States, it is entirely practicable to grow peas and to fatten swine upon them in the fields in which they have been grown. This method of harvesting peas with swine is practicable wherever Canada field peas are grown, but in climates of much rainfall in the autumn months the grazing would be attended with considerable loss, and on clay soils much injury would be done to the land. Moreover, it would always be accompanied by a loss of the straw for food, but where other fodder is plentiful, this loss would be more than compensated by the saving in labor effected by harvesting the crop in this way.

In western Minnesota and in much of North Dakota and South Dakota it would be entirely practicable to grow and harvest peas thus, as the autumn season in the areas named is usually dry. Peas will also yield well in those areas when properly grown; hence, there would seem to be no good reason why in these localities peas should not be made to take the place of corn in fattening swine and with much less labor involved than is called for in growing and feeding corn. The peas are grown in the same way as when grown for the grain. The swine may be turned in to feed upon them as soon as they are of full size in the pods, and the grazing may, of course, continue until the crop is consumed. If the swine can have access to alfalfa pasture while thus gleaning, the profits will be increased, but on peas alone swine will keep healthy and gain rapidly. The fattening period will cover 60 to 90 days, according to the condition of the animals when the harvesting of the crop begins, and the increase in weight should be not less than 1 pound for each animal daily.

In all or nearly all the valleys of the mountain States it would thus be possible to produce an immense amount of pork in the aggregate and at very low cost, and this would follow whether the peas were successfully grown with or without irrigation. In all these valleys the conditions which produce good crops of peas will also produce good crops of alfalfa. Swine can be very cheaply grown on alfalfa with the addition of but little meal or grain until the season arrives for finishing them on peas. The same areas produce barley readily, on which brood sows may be wintered very cheaply when fed along with field roots and alfalfa hay. In no other way can pork be produced more cheaply at the present time in this country or of better quality. While the straw of the pea crop is lost for feeding by this system, it will render good service when plowed under in supplying the land with vegetable matter relatively rich in nitrogen.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 225.

xperiment Station Work,

XXIX.

Compiled from the Publications of the Agricultural Experiment Stations.

Y BY SMOKE AND GASES.
ILIZER MIXTURES.
VARIETIES OF CORN.
G AND JUDGING SEED CORN.
CCO SEED.
EA SEED.
TING SEED OATS FOR SMUT.
O CULTURE.

TOMATO GROWING.
INFLUENCE OF FEED ON MILK.
PROTECTING COWS FROM FLIES.
EXPERIMENTS WITH TURKEYS.
MINERAL MATTER FOR CHICKENS
BROODER HOUSE.
AMERICAN CAMEMBERT CHEESE.
SWELLING IN CANNED PEAS.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFF

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EXPERIMENT STATION WORK.

dited by W. H. Beal and the Staff of the Experiment Station Record.

eriment Station Work is a subseries of brief popular bulletins compiled
the published reports of the agricultural experiment stations and kindred
itions in this and other countries. The chief object of these publications
lisseminate throughout the country information regarding experiments at
ferent experiment stations, and thus to acquaint farmers in a general way
he progress of agricultural investigation on its practical side. The results
reported should for the most part be regarded as tentative and suggestive
than conclusive. Further experiments may modify them, and experience
can show how far they will be useful in actual practice. The work of the
s must not be depended upon to produce "rules for farming." How to
the results of experiments to his own conditions will ever remain the
m of the individual farmer.—A. C. True, Director, Office of Experiment
ns.

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ILLUSTRATIONS.

FIG. 1. **Diagram indicating what fertilizing materials may and may not be safely mixed**

2. Cross section of brooder house

3. Section of brooder house showing south side of alley: *a*, clean-out door rear of brooder; *b*, heater; *c*, lamp pit

4. Plan of brooder house: *c*, lamp pit; *d*, brooder; *e*, window; *f*, chick door

5. West elevation of brooder house

6. South elevation of brooder house

EXPERIMENT STATION WORK.[a]

INJURY TO AGRICULTURE BY SMOKE AND GASES.[b]

The more or less widespread belief that the large quantities of smoke and gases which escape into the air in localities where extensive manufacturing operations are carried on are a direct injury to vegetation and may under certain conditions become a menace to animal life has been shown to be well grounded by many carefully conducted investigations in Europe and this country.

W. A. Buckout, of the Pennsylvania Station, studied the extent of injury to the agricultural and forestry interests of Pennsylvania by pollution of the atmosphere in coking and other manufacturing operations, visiting a number of manufacturing centers and noting the conditions of vegetation in their immediate vicinity. The injurious effect of the gases, smoke, and soot was shown in the destruction of forests and orchards in the vicinity of these manufacturing establishments. Analyses of leaves of various kinds collected in the vicinity of coke ovens and chemical works showed that they had absorbed, to their serious injury, large amounts of sulphurous and chlorin fumes.

He concludes, in general, that "smoke which darkens the air and blackens and defiles whatever it touches, and gases conspicuous to the sense of smell, are in several ways a menace to the health and well-being, the comfort, and convenience of the whole surrounding neighborhood."

The means he proposed for preventing or lessening injury from this source are the erection of tall smokestacks or chimneys in order to secure the most effectual aid in rapid dilution of the gases, the location, if possible, of such works in large open plains instead of in ravines or valleys, as is usually the case, and the use of smoke consuming or condensing devices.

Smoke-consuming devices and means for reclaiming wastes should always be employed and their use be required and enforced by law. There is no more reason why the pollution of the atmosphere should be permitted than the pollution of water or earth. The economics of manufacturing may suggest the need of a more careful and complete combustion of coal or the reclaiming of wastes, but if they do not, then, for the good and well-being of the community at large, the manufacturer should be required to put them in operation. * * * To a degree, attempt is made to regulate these matters by statute, but the provisions are local rather than general, and have not kept pace with the rapid strides made by the manufacturing industries. So far as they have been employed, it has been with reference to city life and surroundings and has had no bearing upon the agricultural interests. There should be a general law upon the subject defining what amounts of smoke and other wastes may be permitted in the air, and prescribing penalties whenever it is found that those amounts are exceeded.

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Pennsylvania Sta. Rpt. 1901, p. [illegible] [illegible]t. Agr., Bureau of Chemistry Bul. 89.

It is a matter of common observation in mining regions that the dense fumes emitted by smelters are particularly injurious to vegetation, and sometimes to animal life, in some localities, as at Butte, Mont., absolutely preventing the growth of vegetation of any kind, and resulting in varying degrees of damage in other localities.

J. A. Widtsoe, of the Utah Station, has reported the results of a careful and detailed study of the nature and extent of damage done to trees, orchards, crops, live stock, and soils by the smoke from copper smelters in or near the towns of Murray and Bingham Junction, some 5 to 7 miles south of Salt Lake City, Utah, as well as of the substances emitted by the smelters.

The most noteworthy substance found in the smelter smoke wa sulphur dioxid, which varied from 59 to 93 parts per 10,000 of ai according to the distance from the smelter (1¼ to ½ mile). The smok also carried considerable quantities of flue dust containing large qua tities of iron, some copper, and traces of arsenic. The general co clusions reached as a result of the investigations were that—

> When the wind causes the smoke to beat upon a field for a considerable len of time, it tends to injure the crops severely and thus to diminish their yiel It tends to injure animals that are right in the line of the prevailing winds, a therefore are compelled to breathe the smelter smoke in the air. It may occ sionally poison pools of standing water, when the washing of rains and mel ing snows cause a concentration of the flue dust in low-lying places. * * It does not injure equally all land within any given radius. The injured fiel are those in the paths of the prevailing winds. It does not injure the fert of the soils of the district.

Practical suggestions to farmers as to how to manage lands s ject to injury by smelter smoke are made as follows:

(1) Don't irrigate on days when wind blows the smelter smoke toward y farm. The injuries from the smoke are always greatest when the soil is

(2) Animals on pasture are likely to gather more flue dust than if they barn fed. As far as possible, therefore, grow hay on the affected pasture

(3) Trees are weakened so much by being robbed of their leaves se times in one or several seasons that death usually follows. It is not advi

to plant orchards or trees of any kind in the districts affected by the smelter smoke.

(4) Annual crops are generally the safest in smelter districts.

(5) Lucern, which is a perennial, appears to withstand the effect of the smelter smoke very well and is a safe crop for smelter districts.

(6) Windbreaks of any kind, sheltering a farm from the direct action of the smoke, would do much to modify the injuries from smelter smoke.

J. K. Haywood, of the Bureau of Chemistry of this Department, has also studied the injury to vegetation by fumes from a copper smelter situated near Redding, Cal. He found that "the vegetation around the smelter for at least 3½ miles north, 9 miles south, 2½ miles east, and 5 to 6 miles west has been greatly injured. * * * It is the opinion of the author that this injury to vegetation will continue and even increase its limits unless the fumes are condensed. The fumes can be condensed and sulphuric acid formed, for which a ready market would probably be found."

It is thus seen that the unrestrained emission of smoke and fumes from manufacturing establishments is already not only a menace to general health and comfort but also a direct injury to agriculture in many localities, and that the damage is likely to increase rather than diminish as the mining and agricultural interests develop unless restrictive measures are adopted. That there are practical means of reducing injury from this cause is demonstrated by the success of the methods practiced in Germany in connection with coke ovens and furnaces, of which it has been said:

> Nothing is more striking than the quiet and cleanliness which prevail about these establishments. Nothing is wasted; scarcely a fleck of smoke escapes from the ovens or rises from the tall chimneys. The air is clear and undefiled without, and luxuriant crops of grain and vegetables grow up to the very walls of furnaces and coking plants in this country, where every morsel of food is needed and where waste is considered a crime.

INCOMPATIBLES IN FERTILIZER MIXTURES.

In view of the growing interest in the home mixing of fertilizers and the encouragement which the practice has received from the work of the experiment stations,[a] attention should be called to the fact that the indiscriminate mixing of fertilizing materials is not a safe practice. This is due mainly to two facts: (1) When certain materials are mixed chemical changes take place which result in loss of a valuable constituent, as when lime is mixed with guano nitrogen escapes, or in a change of a constituent to a less available form, as when lime is mixed with superphosphates the phosphoric acid is made less soluble; and (2) mixtures of certain materials, as, for example, potash salts and

---

[a] U. S. Dept. Agr., Farmers' Bul. 222, p. [redacted]

Thomas slag, are likely to harden or "cake," and thus become diffi to distribute if kept some time after mixing.

A German investigator[a] has suggested the following diagr which indicates for a few of the more common fertilizing mater the combinations which may be safely made. In this diagram dark lines unite materials which should never be mixed, the do

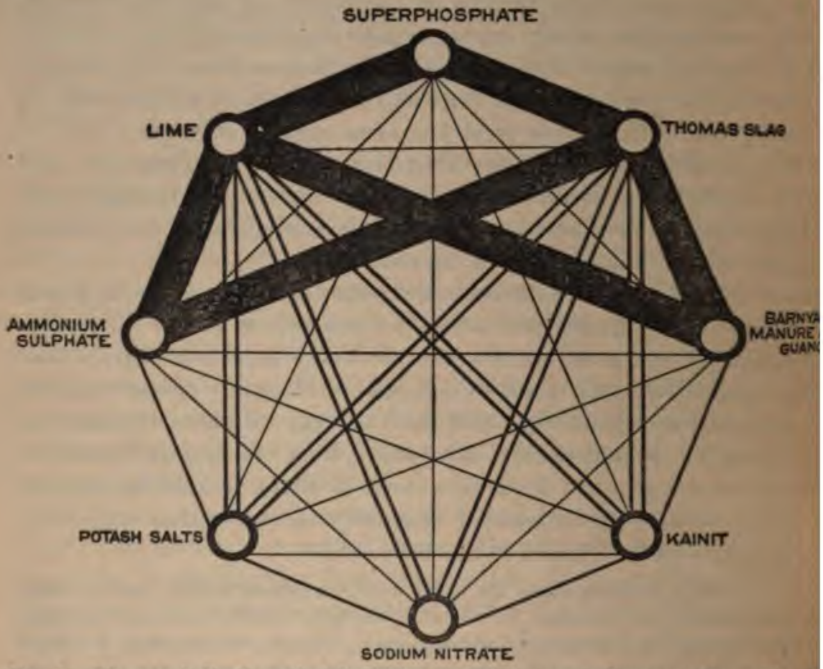

FIG. 1.—Diagram indicating what fertilizing materials may and may not be safely mi

lines those which should be applied immediately after mixing, a the single lines those which may be mixed at any time.

VALUE OF FLINT VARIETIES OF CORN.[b]

In a recent bulletin of the Connecticut State Station, Director E. Jenkins, writing more especially for New England and the mo northerly regions where corn is grown, says:

> No more important subject connected with dairy farming can engage efforts of farmers and of this station than the improvement of our corn both in yield and in quality. Before the silo came in as a necessary part of dairy equipment and before the feeding value of corn fodder and stover generally recognized—corn being raised chiefly for the ears—we had in

---

[a] Bot. Dept. [Trinidad] Bul. Misc. Inform., 1904, No. 42, p. 61.

[b] Compiled from Connecticut State Sta. Bul. 147.

State many varieties of flint corn, which were perfectly hardy, had been bred with more or less skill for very many years, and yielded shelled corn much richer in protein than we can buy to-day. Corn meal with some bran was the staple feed for cows. With the coming of the silo we have sought after varieties which would give the largest possible yield of "roughage," stalks and leaves, and these appeared to be the southern and western dents. Our smaller flints have been neglected. The cold summer of 1903 was disastrous to the corn crop, and it is believed that many farmers finally lost their crop of seed of these proved but somewhat neglected flint varieties in that year. Are we not in danger of parting with a birthright in letting these flint varieties slip away from us?

While we are seeking to establish some leguminous crop to supply the present lack of protein on the farm, we need also to breed some of these flint varieties, naturally rich in protein, to a still larger production of protein and also of stover.

The classic work of Hopkins and others at the Illinois Station has shown that this is quite possible and has shown how to accomplish it.

Starting with some one of our well-established flint varieties of early maturity, in which it would not be difficult probably now to select ears bearing kernels with 12 to 13 per cent of protein, we may hope to secure an increase of several per cent in the average protein content of our crops of shelled corn.

Such a gain would be of immense advantage to stock feeders and particularly to those who still abide by corn meal as the principal grain feed, along with wheat feed, and look with suspicion on all concentrated "forcing" feeds.

This station has taken up this, together with the other question of increasing the yield of stover, in continuation of the work on the corn crop which it has done in past years.

BUYING AND JUDGING SEED CORN.[a]

The work of the experiment stations on corn breeding, referred to in the previous bulletins of this series,[b] has resulted in great activity in the line of improvement of seed corn both by individual farmers and by seedsmen. It is now widely recognized, as M. F. Miller, of the Missouri Station, states, that "the importance of using seed corn that has been well bred (sometimes spoken of as 'pure bred') is just the same as the use of well-bred animals in breeding live stock. The laws governing the breeding of animals are the same as those governing the breeding of plants, and the arguments in favor of using well-bred animals for breeding purposes apply with equal force to the use of well-bred corn for seed. The terms 'well bred' or 'pure bred' as applied to corn mean much the same as they do in animals—that is, strains or varieties that have been kept pure and selected for a series of years for high production and high quality. The productive power of such corn as compared with that which has received little attention in the matter of selection is very marked, the well-bred varieties often yielding from 5 to 40 bushels more per acre under co ditions exactly similar."

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[a] Compiled from Missouri Sta. Circ. of Inform. 19.

[b] U. S. Dept. Agr., Farmers' Buls. 193, p. 20; 210, p. 11.

Many professional corn breeders are engaged in the developme of " pedigreed " corn, and it is probable that for several years to con many farmers will get their seed corn from this source. " In suc case the corn should always be bought in the ear. The corn whic seedsmen or breeders sell in the ear is usually the most select, and th is the kind to buy. Moreover, a man should know exactly the cha acter of the corn he plants. It will always be economy, therefor unless one knows definitely the kind of ears shelled, to pay the extr price for ear corn. Another thing that farmers should be caution against is the buying of corn from men who are not perfectly re liable."

The characteristics which distinguish the most improved types o corn have been fully described in the earlier bulletins of this serie above referred to. The points which it is desired to emphasize here are that if the farmer is not prepared to breed his own seed corn he should buy improved corn only from a reliable grower and in the ear, and examine it carefully to see that it is of the type and quality desired.

TOBACCO SEED.[a]

In a recent bulletin of the Connecticut State Station, A. D. Shamel, of the Bureau of Plant Industry of this Department, calls attention to the fact that the most vigorous and productive tobacco plants can be obtained only by using the heaviest seeds.

> This is partly because the heavy seed has the most perfect embryo or plantlet in it and the largest supply of available plant food to support the seedling until it has developed roots and leaves so as to feed itself.
>
> One of the causes of freak tobacco plants—that is, such as top out prematurely or differ in shape and quality of leaf from the bulk of the crop—is the sowing of small and light seed. In a series of extensive experiments in the Connecticut Valley, the writer separated samples of seed of the varieties grown in this region into light, medium, and heavy grades. In all cases the small and light seed produced the earliest plants in the seed bed, and these plants when set in the field developed a large percentage of undesirable plants which are almost a total loss to the grower. * * * Heavy seed produces large, healthy, uniform, and well-developed plants. * * *
>
> Many of the light and inferior seeds are of the same size as the heavy and desirable seed, and the difference generally between large and small seed is slight, so that it is not possible to separate the desirable from the undesirable seed by screening with any kind of sieves.
>
> The common method of water separation was found to be thoroughly unsatisfactory.
>
> A seed separator making use of an air current was therefore made and was successfully used. This consisted of a glass tube 1 inch in diameter and 5 feet

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[a] Compiled from Connecticut State Sta. Bul. 148.

long, and a glass receptacle for holding the seed, having the diameter of the long glass tube, and so arranged with a finely woven wire screen in the bottom as to hold the seed in the receptacle and at the same time freely admit a current of air directly into the seed. The top of this receptacle is fitted with a coupling into which the long glass tube can be set and held in place. The current of air is generated by a common foot bellows, and regulated with a valve.

The seed to be separated is poured into the receptacle, usually about 1 to 2 ounces at a time, the glass tube set in place, and a current of air pumped into the seed. The lightest seed and the chaff are first blown out of the tube, and next the small seed. Small seeds of the same character as the larger seeds have proportionally more surface than the larger; consequently the small as well as the light seed is removed by this machine. It is believed that machines constructed on this principle will be found satisfactory.

A large number of tobacco growers in Connecticut are this year following Mr. Shamel's advice to separate their seed and grow their tobacco only from the heaviest and best seeds they have.

COWPEA SEED.[a]

A bulletin of the Oklahoma Station calls attention to the fact that cowpea seed always commands a good price, and, in fact, that the price is often so high as to restrict the area planted. This is due to the fact that the peas are difficult and expensive to harvest and store.

The bulletin discusses two methods generally used in harvesting cowpea seed—namely, hand picking and cutting and thrashing the vines. Thorough harvesting by hand requires several pickings at different dates, and as the price of efficient farm labor is usually high this method of harvesting is expensive, it being estimated that hand-picked peas cost from 75 cents to $1 per bushel for harvesting. Waiting until the vines are ripe and cutting and thrashing or flailing results in a considerable saving of labor and expense, but is accompanied by a considerable loss of seed.

The scythe-mower, one of the bean harvesters found on the market, or an improvised cutter may be used in harvesting the peas. Cutting with the scythe is laborious, and the ordinary mower is difficult to operate in heavy and tangled vines and wastes peas by shelling. On the whole, the best way to harvest the cowpea vines appears to be to cut off the plants just below the surface of the ground by means of a bean harvester. Where much cowpea seed is to be raised in the most economical way such a machine is considered indispensable. The small farmer, however, can not afford a bean harvester. He can use practically the same method by making a knife about 18 inches long with a shank on one end of it about 10 inches long for attaching it to the shank of a cultivator. The knife should be made out of good spring steel, and when it is placed it should slope backward at an angle of a little less than 45° and slightly down at the free end. The blade should be at least 2 inches wide and a fourth of an inch thick and reenforced at the heel, as good-sized plants will give it quite a strain. After a little experience in adjusting, the operator will find it a very useful implement for the purpose and quite inexpensive. The advantage in cutting the plants below the ground is that not near as much seed is shattered in cutting. In this, as well as with the other methods, the vines bearing seed should not be run over by horses or implements. If they are in the way, put them to one side with forks. After cowpea vines bearing seed have been cut it is desirable to get them stored or thrashed as soon as possible, as the sun causes the pods to shed the seed. Usually the vines are so green and contain so many green leaves that they can not be put in a stack or mow without some curing in the field. The vines should be put in cocks at once after cutting, and after a day or so curing in the field be put in small loose stacks or in mows, where the beans that shatter out may be saved. Many times half of the seed is allowed to shatter out after the vines have been shocked by leaving them in the field too long. The greater part of the drying and curing should be done in the stack or the mow.

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[a] Compiled from Oklahoma Sta. Press Bul. 112.

The vines that have ripened seed are not near as sappy and hard to cure as when they are cut early for hay. If the grain is to be flailed out it can be done with more ease if the vines are pretty well dried out. If the grain is wanted for seed it is not practicable to thrash the crop with a common thrasher as the grains crack so readily. Some report that by putting in blank concaves and removing some of the teeth from the cylinder and reducing the speed the work is satisfactory, but our experience, after taking all these precautions, is that too many peas are cracked to make the operation practicable when the peas are selling at the present high prices. Flailing out the seed will be found the best for the average farmer. When the pods are well dried the operation is not expensive or laborious.

Cowpea seed is often greatly damaged in storage by the weevil. Such damage can be prevented by putting the seed in a close covered bin and placing a dish of carbon bisulphid on the top of the seed. The carbon bisulphid evaporates rapidly and the heavy fumes sink into the mass of the seed and destroy the weevils. The operation should be repeated several times during a season if the seed is to be kept free from the weevil.

In small quantities the carbon bisulphid costs 15 to 25 cents per pound. As a rule, 1 pound of the liquid will treat 30 bushels of the seed. The liquid and the gas are very inflammable and poisonous and all fire should be kept away from it. If the weevils are kept out and the seed is stored in a dry place it will retain its vitality two or three years.

TREATING SEED OATS FOR SMUT.[a]

In a recent bulletin of the Indiana Station, J. C. Arthur, who has been making a careful study of the subject for many years, says:

The farmer who raises oats is very likely to sustain a considerable loss of his crop from the presence of smut in the field. Oat smut is a fungus that starts when the seed germinates, grows inside the stalks, using part of the nourishment of the oat plant, thereby preventing the stalks attaining full

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[a] Compiled from Indiana Sta. Buls. 87, 103.

> height, and winds up its career by turning the grain, and often the chaff, into a black powder, which is made up of the reproducing spores of the fungus. If this black powder gets upon the seed grain sown the following year, the resulting crop will be correspondingly injured by smut.
>
> Oat smut is very common throughout the State and the country at large. Unless preventive measures have been taken, almost any field will show from a few per cent to 10, 15, 25, or even 50 per cent of smut. Any amount under 10 per cent attracts little or no attention, because the affected stalks are, for the most part, so much shorter and less conspicuous than the healthy ones, due to the dwarfing action of the fungus. * * * If any farmer doubts that he is losing from 1 to 10 bushels or more of oats out of every hundred that he harvests, let him go into his field and count every stalk, little and big, to the extent of 500 or 1,000 in different parts of the field, making note of the number of those blasted with smut, and he will be surprised at the result. He should not be deceived into thinking that some of the stalks are too small to be worth counting, for if it had not been for the attack of smut they would have been as large as the others and borne full-sized heads of good oats.

W. A. Henry, of the Wisconsin Station, estimates the loss from oat smut in Wisconsin alone at from $3,000,000 to $7,000,000 annually, according to the season and other conditions. The great value of an efficient practical method of prevention of smut is obvious.

The formalin method of treatment "has proved remarkably efficient, cheap, and easy of application, and comes as near to being an absolutely satisfactory process as any known for a fungus disease." This method, as Professor Arthur describes it, is as follows:

> Sprinkle the seed oats with a solution of formalin of the strength of 1 pound of formalin to 50 gallons of water until nearly moist enough to pack in the hand, shovel into a pile, and cover. After two hours or more the oats are ready to sow, or can be spread out and dried and kept for future sowing.
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> Formalin is a gas dissolved in water, and the reason for covering the oats is to keep it confined and give time for the gas to penetrate between the chaff of the grain, and thus reach every spore of the fungus and kill it. After the spores are killed it is immaterial whether the grain is sown at once or dried and sown after a time. If sown without drying, a little more per acre should be used to allow for swelling.
>
> The efficiency of this method has been fully tested and is beyond question. Its cost is about 1½ cents per bushel, or less, for the material. Formalin can be bought at almost any drug store. The time and labor required are not great, and the returns are ample.

An application of this method of treatment, which promises great practical usefulness in the grain-growing regions, is in the treatment of seed oats on a large scale in the elevators. A great deal of seed oats is bought directly from the elevators, and Professor Arthur's experiments at a local elevator show that oats may be rapidly, efficiently, and cheaply treated for smut in the elevator.

> All the handling of the grain being done by machinery made it possible to apply the formalin treatment most expeditiously at the rate of 500 bushels per

hour. Formalin was used of the strength of 1 pound in 25 gallons of water, and about 100 gallons of the solution used for each 500 bushels of grain. The cost of the formalin for this amount of grain is therefore from $1.20 to $1.60, according to the retail market price at the place of purchase, or about one-third of a cent per bushel.

To carry out treatment in this manner it is necessary to have a vertical drop or chimney about 3 feet square and 40 to 50 feet high. On the inside of this drop are placed shelves or deflectors sloping downward, alternately on two opposite sides from top to bottom. As the grain drops from the top it is tossed from side to side as it strikes against the deflectors in its fall, and is thus thoroughly mixed. By means of a small steam pump the solution of formalin is thrown against the falling grain, near the top of the drop, in a fine spray. The rate at which the grain is allowed to flow determines the amount of solution applied per bushel. By the time the grain reaches the bottom it has been so agitated that the moisture is distributed with perfect uniformity.

The grain is allowed to remain in the bin at the bottom of the drop, or run into another bin, as may be most convenient, and after standing not less than two hours, or over night if desired, it can be taken to the field for sowing, or can be run again through the drop and this time dried out by a blast of cold air. After drying, the oats may be kept indefinitely or shipped. Oats thus treated are not injured for feeding, but if properly handled are even improved by killing deleterious germs other than smut spores. * * *

There are already a number of grain elevators in Indiana fitted with machinery for this work. Some of them will treat seed oats in this manner for any farmer without additional charge, and the expense in any case will amount to little more than the time of going to the elevator, while the profit to the farmer may be considerable.

POTATO CULTURE.[a]

As a result of a large number of experiments, F. W. Rane, of the New Hampshire Station, gives the following concise directions regarding the culture of potatoes in New England:

Soil and location.—The ideal potato soil is deep, friable, retentive of moisture, and well drained. Heavy clay and very light sandy soils should be avoided. Stony land renders planting and cultivating difficult and expensive. The presence of decaying organic matter in the soil not only furnishes valuable plant food, but also increases its water-holding capacity. Everything else being equal, a northern slope would be preferred to a southern one, except when grown for early use, as the crop is sometimes badly injured by the intense heat, increased by a southern exposure during a hot, dry season.

Manure.—Fresh stable manure, especially when harrowed in, tends to produce such diseases as scab, blight, and rot, and should therefore be applied, if possible, to the crop preceding, and enough used to provide for the needs of both crops.

The potato thrives best in a cool, moist soil, and, unlike the corn crop, roots quite deeply. It is therefore recommended that stable manure be plowed in for the above-mentioned reasons, and also to prevent the germination of the weed seeds contained in it, thus greatly reducing the cost of hand cultivation.

When a crop is to be grown on freshly broken sod, the best results will generally be obtained by plowing in a light application of stable manure, and using in the drill 8 to 10 hundredweight per acre of a good high-grade fertilizer.[a]

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[a] Compiled from New Hampshire Sta. Bul. 111.

Chemical fertilizers.—In large potato-producing sections where the supply of stable manure is limited many growers are obtaining splendid results from the exclusive use of chemical fertilizers, using about 1,500 pounds per acre. Where the physical condition of the soil is poor we should recommend plowing under a crop of clover, peas, or other legumes, and the application of 12 to 15 hundredweight per acre of a high-grade fertilizer. In using either stable or chemical manures an excess should be avoided, as it tends to produce an overgrowth of vines, which excludes the air and sunlight, thus favoring the conditions which invite and spread the attacks of the blight.

One hundred bushels of potatoes contain about 12.6 pounds nitrogen, 4.5 pounds phosphoric acid, and 30 pounds potash.

The knowledge of the analysis of the crop is of little value to the grower until he has studied his soil and learned its needs; but, knowing both, he will be able to apply at the lowest cost the proper amount of plant food required to produce a full crop.

Preparing the ground.—The time for plowing will depend largely upon the nature and situation of the field. If infected with quack grass or located upon a slope that is liable to wash, spring plowing would be preferred. If plowed in the fall, an extra amount of harrowing will be necessary in order to obtain the same results as produced by spring plowing. Whatever the time selected for plowing, the soil should be harrowed and pulverized in a thorough manner, not being content with stirring and leveling the surface only, but using such harrows as will work deep and leave the soil in the best condition to receive the crop.

Seed.—Good seed is one of the essentials to success in growing this crop. As the potato decreases in vitality when grown from poor stock, it is best to either select carefully our own seed by saving the product of such hills as yield the greatest weight of smooth, marketable tubers, or buy from a reliable grower whom we know to be selecting his seed in a like manner.

It is a false idea of economy to save a few dollars per acre by using cheap seed, and thereby ruin your chances of success at the start. The fact that many growers are planting small and indifferent seed year after year largely accounts for the low average yield reported, and also for the deterioration of most varieties after eight or ten years in the hands of the average grower.

Small to medium tubers grown from seed selected as already mentioned, that have not lost their vitality by sprouting, will generally produce a more satisfactory crop than larger seed of the same variety grown from a poor strain of tubers that have been weakened by excessive sprouting.

Varieties.—As our New England markets demand a round or oblong white potato, we recommend for main crop the planting of such varieties as the Green Mountain and Delaware, or varieties that closely resemble them.

As seedsmen are each year introducing and selling at fabulous prices new and untried varieties, the most of which are soon dropped from their catalogues and forgotten, we advise growers to depend on standard sorts that have been fully tested and found adapted to their soil and market, and allow their experiment station to test the novelties for them, thus preventing a large annual waste of time and money.

Planting.—The time for planting will depend upon the soil, locality, and season. If wanted for early use, the seed should be planted in April, while for main crop the work may be done between the 1st and 20th of May.

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[a] Containing 3 per cent of nitrogen in nitrate of soda and sulphate of ammonia, 6 per cent phosphoric acid in dissolved boneblack, and 10 per cent of potash in muriate or sulphate of potash.

Improved planters are rapidly coming into general use among the large growers, and while their cost prohibits their ownership by the average farmer, the purchase of one is generally recommended in cases where 6 or more acres are annually planted. Unless great care is taken in cutting the seed to have the pieces uniform in size and shape, and good judgment exercised in operating the machine to secure an even distribution of the seed and fertilizer, also straight rows and proper covering, the advantage of the planter will be lost. The depth for covering should depend upon the nature and condition of the land; in low or clayey soils 3 inches will be sufficient, while upon light, well-drained land a covering of 4 inches is advisable.

The distance for planting should be governed by the fertility of the soil and the variety used, as well as by the number of eyes on each piece of seed. A good rule for most conditions is to use seed cut to two or three strong eyes and plant every 15 to 18 inches in rows 3 feet apart.

Cultivation.—This is a very important operation, and must be attended to at the proper time if the crop is to be kept clean and thrifty at a minimum cost. The neglect of a few days in one cultivation may mean the difference between profit and loss. Cultivation should begin by stirring the soil with a weeder or smoothing harrow within one week from time of planting, and the operation repeated every week or ten days as long as the size of plants will admit, the objects sought being to prevent crusting of the surface soil and the extermination of weeds before they have gained foothold in the soil.

The horse cultivator will next be of service in cultivating the crop, and should be run quite deep for the first cultivation, after which all operations should be shallow, as deep cultivation after the plants have become well established causes untold injury to the roots feeding in the top soil.

The amount of hand hoeing necessary will depend upon the thoroughness of the above operations and the amount of grass and weed seeds in the soil. If the weeding and cultivating has been faithfully done, the only necessary hand work should be in the removal of the scattering weeds along the row.

Diseases.—The principal diseases are the early and late blight and scab.

The early blight usually appears from the middle to the latter part of July, during hot, dry weather, and causes a premature dropping of the foliage, but is unattended by rot.

The late blight usually appears in August and spreads very rapidly during warm, moist weather. Its attacks are sudden and destructive, and are usually accompanied by rotting of the tubers.

The above diseases may be prevented by thoroughly spraying with Bordeaux mixture. The first spraying application should be made when the vines are 8 to 12 inches high, which with the late varieties will be about July 15. The number and frequency of later sprayings will depend largely upon the weather. Usually four to five times will be sufficient, unless washed off by heavy rains, the object being to keep the vines covered with the mixture at all times after the first spraying. To destroy the potato beetle, one-fourth to one-half pound of Paris green should be added to each 50 gallons of mixture. To prevent the scab, avoid contaminated land and seed, also excess of fresh stable manure. Seed that is affected, and smooth tubers that have been selected from affected stock, should be treated with formalin or corrosive sublimate solutions before planting.[a]

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[a] U. S. Dept. Agr., Farmers' Bul. 91.

FURTHER POINTS IN TOMATO GROWING.[a]

The Ohio Station has recently published in bulletin form the results of a number of years' work at that station in the forcing of omatoes. The station reports that while tomatoes are profitably forced in midwinter near large cities in the East, the practice has gained but little headway in Ohio. The prices received are not sufficiently high to make it profitable. In growing early spring and summer crops under glass there has usually been good profit. The omatoes grown at the station have been marketed for the most part n small cities near the station and in Cleveland.

> The most noteworthy fact in this connection is that while these markets have been well supplied with southern tomatoes, the prices received for greenhouse omatoes have been considerably above and often double those quoted for the southern product. This is because of the superiority of well-ripened greenhouse tomatoes over those shipped in a green state from the South. There is a steady demand, even in small cities, for the home product at prices which are remunerative. At the season when tomatoes can be grown in the greenhouse o best advantage they are more profitable than either lettuce or cucumbers during the same period. The crop is one well deserving the attention of those engaged in vegetable forcing.

In recent experiments at the station the early yields with both Stone and Beauty varieties were much in favor of plants set 1 foot apart each way and trained to a single stem. The total yield also of the Stone variety was greatest when the plants were thus spaced, and nearly as good results were secured with the Beauty variety. The general conclusion was that in planting 2 feet apart each way, as has been the usual custom at the station, the plants have not been crowded so closely as they might have been to secure the highest yield per square foot. Early yield, which seemed to be favored by close planting in this experiment, is of especial importance because of the increased price received for the early product.

A large number of experiment stations, including Maine, Virginia, New York, and New Jersey, have also reported the results of pruning omatoes to one or more stems and uniformly recommend the single-stem training. On this point the New York State Station reports as follows:

> Single-stem training is clearly superior to three-stem training for forcing omatoes in winter in this climate. The superiority is seen in the larger yield of early ripening fruit and in the larger total yield. There is but slight difference in the average size of fruit produced under the two methods of training, but on the whole the fruit of the single-stem plants seems to be slightly he larger.

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[a] Compiled from Ohio Sta. Bul. 153; New York State Sta. Bul. 125. For an earlier account of tomato culture see U. S. Dept. Agr., Farmers' Bul. 186, p. 12.

Another point reported upon by the Ohio Station is the matter of subirrigation of tomatoes in the greenhouse. The subirrigated tomatoes gave considerably larger yields than surface-watered tomatoes. The average size of the fruits of the subirrigated tomatoes was also larger and the amount of rot per square foot very much less than in the case of the surface-watered plants. On this subject the station states that—

> In our experiments we have found that by repeated watering on the surface the soil, unless more porous than the average greenhouse compost, becomes packed, and as a result, unless considerable care is exercised in watering, the lower portion of the bed will often become quite dry, even though the upper surface be thoroughly soaked. This not only results in a check to the growth of the plants, but if it occurs after the fruit has become well developed it will often cause a considerable loss from dry rot. On the other hand, when the water is allowed to rise by capillary attraction, as is the case when subirrigation is practiced, the soil is kept open and porous and in good condition for the free access of air and acts as a sponge in taking up and holding a large amount of water. Subirrigation not only gives the best growth of plants and highest yield, but it also serves as a check to the disease known as dry or tip rot.

In this connection the value of a mulch with subirrigation is pointed out. A grower, near Wooster, is reported to control the moisture of his tomato beds by subirrigation and the use of a mulch. The best results have been secured by mulching as soon as the tomatoes are planted in the bed. The surface of the mulch is allowed to become dry and remain in that condition for some time.

> If the mulch is kept wet on the surface from the start the presence of the moisture seems to bring about conditions which promote disease. Toward the close of the season he surface-waters the mulch and thus washes some of the fertility out of the manure into the soil, where it is available for the crop when it is most needed. Where the water supply is scanty, mulch should be used whatever method of watering is employed, and it will be found beneficial in all cases. * * * Mulching with strawy manure accomplishes the same results as subirrigation. It is more beneficial, however, with surface watering than with subwatering.

INFLUENCE OF FEED ON MILK.[a]

The extent to which the composition of milk, especially its fat content, can be influenced by the food of the cow has been the subject of much discussion and difference of opinion. H. H. Wing and J. A. Foord, of the New York Cornell Station, discussing this question, say:

> For a long time the opinion has been very strong in the minds of dairymen that the percentage of fat in milk is directly and largely influenced by the food of the cow. If ninety-nine out of a hundred dairymen are asked whether they can make their cows give richer milk by changing the food, they will answer once in the affirmative, and many will go so far as to say that they have ne it time and again. Still, this is one of the results that careful investigators

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[a] Compiled from New York Cornell Sta. Bul. 222.

have been trying to secure for the last twenty years, and so far they have met with little or no success.

While a summing up of all the work on this subject heretofore done in this country and abroad would indicate that, in general terms, "it is not possible materially and permanently to increase or diminish the percentage of fat in the milk of a cow through changes in the amount or character of the food," it was thought that these results were not conclusive, because the experiments were, as a rule, made with cows which had previously been well fed and cared for.

The author therefore undertook to determine what would be the effect on the milk of high feeding of cows which had previously been insufficiently nourished. The experiments were made with 10 cows from a single farm herd of 21 cows of mixed breeding, only 4 of which were over eight years of age, thin in flesh at the beginning. At the height of the lactation periods the cows were given all they would readily consume (averaging 8 to 12 pounds daily) of a grain ration made up largely of cotton-seed meal, wheat bran, gluten feed, buckwheat middlings, and old-process linseed meal, with occasionally ground oats and corn meal. The proportions and combinations of the different feeds varied at different periods. The improved ration contained about twice as much digestible protein as the cows had formerly been receiving.

The results show that "in a herd of poorly fed cows an abundant ration, easily digestible and rather nitrogenous in character, and continued through two years, resulted in an average increase of one-fourth of 1 per cent of fat in the milk (or a percentage increase of about 6 per cent). This was accompanied by an increase of about 50 per cent in total amount of milk and fat produced. The increased production was secured economically so far as the food cost of milk and fat is concerned."

The improvement of the general condition of the cows receiving the richer rations was very rapid and very marked.

PROTECTING COWS FROM FLIES.[a]

Of the various remedies suggested for relieving cows of the annoyance from flies, some have proved more or less efficient. In considering the use of such remedies it seems desirable, therefore, to determine what effect, if any, flies have on milk production. Several stations have published data which bear on this point.

In 1899, W. L. Carlyle, of the Wisconsin Station, reported an experiment in which seven cows were practically protected from flies during the daytime by confinement in a comfortable stable provided with screen doors and windows, and several other cows, confined in a small lot abundantly supplied with shade trees, were constantly on the move fighting flies. Both lots were pastured at night, received the same kind and amount of grain feed, and also all the freshly cut sorghum and green corn that they would eat readily. The cows confined in the stable ate more of the green corn and sorghum, but lost more in live weight during the four weeks of the experiment than the cows left out of doors. During the first two weeks of the experiment the cows in the stable produced 56.7 pounds of milk less than during the two weeks previous, while the cows not confined decreased only 40.4 pounds. The corresponding decrease in the production of fat was 0.81 pound for the stabled cows and 2.16 for the cows not stabled.

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[a] Compiled from Connecticut Storrs Sta. Bul. 32; Massachusetts Sta. Rpt. 1902, p. 61; Oregon Sta. Rpt. 1903, p. 29; Wisconsin Sta. Rpt. 1899, p. 92.

This experiment can not be accepted as in any way conclusive, and yet it would seem to indicate that while the cows in the stable increased slightly more in the percentage of butter fat in their milk than did the lot in the paddock, yet they ate more of the feed and fell off more in the amount of milk given, though they decreased much less in total fat production. It is easily seen, however, that the increase in the total amount of butter fat given in the one lot over the other in this experiment was not sufficiently great to pay for the increased trouble and expense entailed in the stabling of the cows during the greater part of every day.

In an experiment at the Oregon Station a proprietary remedy for repelling flies was applied to four cows from July 25 to September 30. These cows gained 265 pounds in weight during the period of treatment, while four cows kept under similar conditions, but not treated, gained only 212 pounds. Two of the treated cows showed a shrinkage of 12.6 per cent in milk production during August and September as compared with their yields during the two months preceding this period. Two other cows not treated showed a corresponding shrinkage of 22.4 per cent. While the results indicate some advantage from the use of the fly repellant, the data reported are not sufficient to warrant a definite conclusion from the standpoint of economy.

In 1902–3 C. L. Beach and A. B. Clark conducted experiments on this subject which have been published very recently in a bulletin of the Connecticut Storrs Station. The station herd was divided into two similar groups, one of which was treated daily with a proprietary remedy for repelling flies during the first, third, and fifth weeks of the experiment in 1902, and the other lot during the second and fourth weeks of the same period. In all other respects the two lots received the same treatment. The experiment was repeated in 1903 on the same plan, except that the periods were increased to two weeks and the records of only the second week of each period were used in order the

the possibility of the effects of the treatment extending from one period into the next might be avoided. It is stated that the remedy the second year was efficient as a fly repellant. On several occasions the milk had a peculiar odor, which was attributed to the remedy. No appreciable gain either in the production of milk or butter fat was considered due to the use of the fly repellant in the experiments. The conclusions, as stated by the authors, are as follows: "(1) The annoyance of cows by flies seems to be overestimated, and (2) certain proprietary ointments, known as 'fly removers,' will protect the animal to a greater or less extent, but their use has little or no effect on the milk or butter-fat secretion."

It would rather seem, therefore, that no great claim can be made for such remedies on the ground of economy of milk production. However, the results of experiments with such proprietary remedies do not warrant sweeping conclusions as to the general question of the advisability of protecting farm animals from annoyance by flies. Under more extreme conditions of annoyance the benefits of efficient protection would probably be more marked, and it is obvious that in many cases such protection is demanded from humanitarian considerations, if for no other reason.

RECENT EXPERIMENTS WITH TURKEYS.[a]

Although turkey raising is an important branch of the poultry industry, little experimental work has been carried on with this class of poultry at the agricultural experiment stations as compared with the amount of work which has been done with chickens and ducks. For many years the Rhode Island Experiment Station has studied the breeds and breeding of turkeys, the development of the turkey industry, and the characteristics and treatment of turkey diseases. This work, which has furnished results of great interest and value, is being continued.

As is well known, turkeys retain many of the characteristics of their wild state. They roam extensively, gathering much of their own food, and unless prevented will make their nests in out of the way places, where they are free from interference. In some regions, particularly the southern United States, it is a custom to gather the turkey eggs and hatch them under hens, as they may be thus cared for more successfully than otherwise. The young chicks are delicate, and if hatched by a turkey they are apt to roam with the mother while yet too young, and the percentage of loss will be very high. If the turkey is allowed to sit, there are other difficulties to be met, as the nests are often some distance from home, and it is not easy to look after the hen when she has commenced to sit nor can the young be readily attended to when hatched. Believing that a considerable saving would be effected if turkeys could be confined during the laying season without an injurious effect upon the production and fertility of eggs, O. M. Watson, of the South Carolina Experiment Station, studied the problem with Bronze and White Holland turkeys, two hens and a male bird of each variety being used. The two lots were confined in runs 80 by 100 feet long, and were given a variety of feed—in the morning a mash composed of equal parts of wheat bran and corn meal and on alternate nights whole corn and wheat. At all times they had access to oyster shells, and were fed ground bone and meat scrap twice a week. Two nests a yard square were provided in each run. They were covered at the top to keep out rain, and were partly hidden behind brush. Both breeds began laying late in March, the Bronze producing 42 eggs and the White Holland 36. On the tenth day examination showed that 38 of the Bronze turkey eggs and 27 of the White Holland were fertile. The number of eggs hatched with each lot was 27 and 16, respectively. "During incubation 4 eggs were broken by the Bronze hens and 6 were broken by the White Holland, all of which were fertile. The eggs that did not hatch were those laid during the first two weeks."

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[a] Compiled from Ann. Rpts. Live Stock Assocs. Ontario, 1902, p. 107; Canada Expt. Farms Rpt. 1897, p. 331; Minnesota Sta. Bul. 91; Rhode Island Sta. Rpt. 1904, pt. 2, p. 174; South Carolina Sta. Bul. 74.

As will be seen, it was possible in this test to induce the turkeys to lay in the nests which were provided for them, and a fairly large percentage of the eggs laid proved fertile.

Data collected by the Ontario Department of Agriculture from a number of successful poultry raisers furnishes additional information on this point. One of the turkey raisers quoted states that if barrels or boxes are placed in secluded spots around the farm buildings, with some straw for nests and a nest egg, the turkey hens will very seldom wander to the woods, especially if the nests are made in good season. Another writer states that when nests are prepared in the orchard with brush and old boards, in such a way that they resemble a brush heap, the turkeys are very apt to lay in them. It was also noted that young birds lay earlier than the older birds. If turkeys are well fed in the spring they will begin laying before the fence corners and rubbish heaps, which they prefer for nests, are free from snow, and under such circumstances they are more likely to make their nests about farm buildings.

According to a recent English agricultural journal,[a] a large tub or barrel laid on one side may be satisfactorily used for a turkey nest. A round nest should be shaped from damp soil, well beaten down, with a little slaked lime shaken over the inside, which makes it firm.

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[a] Mark Lane Express Agr. Jour., 92 (1905), No. 3839, p. 545.

The nest should be lined with fine hay. A large nest from 20 to 24 inches square should always be provided, as otherwise the tail feathers become injured and do not get straight again before the birds molt. The article quoted recommends corn, barley, and dry rice as the best grains for turkeys while sitting and emphasizes the importance of proper feeding at this time.

The data collected by the Ontario Department of Agriculture offer some information regarding turkey management and fattening. A liberal use of insect powder about the nests and on the old birds and young chicks is recognized as an important measure. In general, the turkey raisers quoted agree on the importance of strong, healthy breeding stock, the need of confining the young turkeys for two or three weeks after hatching, protection from dampness, and the feeding at first with soft feed, which, however, should not be sloppy.

As regards the young birds, one feeder recommends for the first week stale bread soaked in milk and pressed quite dry, and after this such feeds as hard-boiled egg yolks with stale bread crumbs. Occasionally a little black pepper may be used, and the young birds should be fed every two or three hours. Sour milk curds, with finely cut onion tops and dandelions, are also recommended, the green feed being regarded as especially desirable. When two or three weeks old, the young turkeys can be fed grain, and, of course, should always be supplied with fresh water, grit, and the necessary green feed. As they grow older they are allowed to roam, and when they have access to stubble fields, and grasshoppers are abundant, they will need little feed except what they can gather until it is time to fatten them for the Thanksgiving or holiday trade. For fattening, a favorite grain mixture is corn, oats, and wheat. One of the writers quoted suggests finely chopped buckwheat, oats, and barley 1:2:1, a little commercial poultry food rich in protein being added, and the whole moistened with milk. The hulls should be removed from the finely chopped grain by sifting.

In a discussion of the essential features of poultry raising under local conditions, recently published by the Minnesota Agricultural Experiment Station, C. E. Greene makes some statements regarding turkeys which are based on personal experience.

The young chicks are allowed to roam at will and are fed occasionally some corn cake. For fattening, barley and corn soaked or boiled for a short time, are considered good feeds. "If the turkeys are kept in a slightly darkened room and fed heavily for about three weeks the quality of the flesh will be very much improved, and they will generally pay for the feed in extra weight." For the winter feeding of breeding stock whole corn, wheat, or barley, with grit and water, are recommended. "Twice a day is often enough to feed them.

They do not need a warm place in which to roost. They will do better in a rather cool house with plenty of fresh air."

"The high prices paid for turkeys in November and December and the ease with which they may be raised should stimulate a greater interest in turkeys among farmers who can give them a good range."

A test carried on in Ireland of different methods of fattening turkeys was recently reported by H. de Courcy.[a] Thirty young cockerels of similar breed, which had ranged on stubble fields for about three weeks and had received some grain during the latter part of this time, were divided into three uniform lots, the individual turkeys weighing on an average about 17 pounds each. The feeding period covered three weeks, and during the first ten days all the turkeys were fed in the morning a mash of equal parts of boiled potatoes, boiled turnips, barley meal, maize meal, and ground oats with one-half as much linseed meal, the grain being wet up with skim milk to a rather stiff mash. Milk and water in separate vessels were also supplied, as well as mixed charcoal and grit. The turkeys were fed in a yard, and after an hour for feeding and exercise were turned into a rather dark poultry house, where they remained until evening, when they were again driven to the yards and fed crushed corn, oats, and barley. During the latter part of the test this method of feeding was continued with one of the lots, with the result that the average gain per bird during the entire feeding period was 2 pounds 12 ounces. Of the remaining two lots one was fed twice a day by hand cramming a stiff mash of equal parts of ground barley, corn, and oats with a small amount of melted fat, linseed meal, and skim milk, the mixture being rolled into pellets about 2 inches long and 0.75 inch in diameter. The average gain for the entire period was 3 pounds 6 ounces per bird. The remaining lot was fed with a cramming machine a similar mixture wet up with skim milk to form a slop of about the consistency of cream. Owing to their size and strength, it is stated that at first some difficulty was experienced in feeding the turkeys, but this was soon overcome by placing the birds one at a time on a low stand, which raised them off the ground so that the head was on a level with the nozzle of the cramming machine and in such a position that they could be fed conveniently. "After a day or two the turkeys grew accustomed to this manner of feeding, and when meal times came they showed much eagerness to mount the stand and receive their share of food." With this lot the average gain was 4 pounds 4 ounces per bird. As will be noted, the greatest gain was with the turkeys fed the soft mash with a cramming machine. The cost of feed ranged from 34 cents per head with the turkeys fed without cramming to 41 cents with those fed with a cramming machine.

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[a] Jour. Bd. Agr. [London], 11 (1904), Nos. 7, p. 385; 8, p. 495.

At the Manitoba Experiment Station S. A. Bedford a few years ago studied the gains made by turkeys confined in pens as compared with those allowed their freedom. The birds in pens were given all they would eat clean of a mixture of wheat, oats, and barley 2:1:1. In the morning the grain was fed chopped and wet with milk, but in the evening it was fed whole. It was noted that the turkeys were apparently more fond of oats than of the other grains, so toward the end of the fattening period the proportion of this grain was increased. A little grain was fed the turkeys which were not confined in addition to the food which they could gather. The five turkeys in pens weighed on an average 6.55 pounds each at the beginning of the test. During the forty-two days of the feeding period the average gain was 4.05 pounds, 6 pounds of grain being eaten per pound of gain. The turkeys running at large also weighed at the beginning of the test 6.55 pounds each and made an average gain of 1.85 pounds. In both cases the greatest gains were made during the first three weeks of the period. It is stated that the penned turkeys when dressed shrank 5 per cent less than those running at large and that they were plumper and were in every way more inviting in appearance.

In a recently published statement by G. M. McKeown [a] regarding turkeys and turkey management at the Wagga Experimental Farm, New South Wales, attention is directed to the importance of bronze blood in improving common stock. "The pure [bronze] gobblers * * * are remarkably prepotent and will rapidly improve the quality of any flock into which they are introduced. The appearance of the young stock is greatly improved, they mature earlier, and the weight, quality, and flavor of the flesh are strongly influenced for the better by the introduction of bronze blood. * * * For some years many gobblers have been bred which at about eight months have weighed, alive, 23 to 25 pounds, while some at nine months have reached 28 to 31 pounds. Pullets have been bred to weigh 16 pounds at eight months, and gobblers which have been sold from the farm have been reported by their buyers as weighing 39 and 40 pounds before they were two years old."

An important feature of the turkey industry is dressing to suit the demands of the market sought. This point was recognized and discussed at length in connection with the Irish tests cited above and is a matter which has been considered in connection with the Canada Department of Agriculture work. A summary of data on this topic based on work of the Canada Department of Agriculture has appeared in an earlier number of this series.[b]

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[a] Agr. Gaz. New South Wales, 15 (1904), p. 1166.

[b] U. S. Dept. Agr., Farmers' Bul. 144.

GRIT AND MINERAL MATTER FOR CHICKENS.[a]

That chickens require a certain amount of coarse mineral matter or grit in order that they may properly grind and assimilate their food is well understood, but that it is also highly important that their food should be amply provided with mineral nutrients, such as lime, phosphoric acid, etc., to build tissue, bone, and eggs (especially shells) is not so generally realized and given consideration in poultry feeding. W. P. Wheeler, of the New York State Station, who has been studying this subject for a number of years,[b] has reported a series of experiments which were made to ascertain what deficiencies in this respect may occur in ordinary poultry foods and how they may be corrected.

It is estimated that about 10 per cent of the daily growth of a chicken is made up of inorganic (mineral) matter. The grains which ordinarily supply the larger part of the food of chickens are comparatively low in mineral (ash) constituents, and will not furnish a sufficient amount of mineral matter for the bodily requirements of the fowl. Where chickens have free range on a farm they will probably get sufficient mineral matter themselves, but where they are fed in confinement and mainly on grains the supply of mineral matter at once becomes important. The experiments of the station have shown that the great benefit which chickens derive from the addition of animal food to their feed is due mainly to the large amount of mineral matter which the animal food ordinarily contains.

In experiments made with 19 lots of from 24 to 76 Leghorn chicks, each fed from ten to twelve weeks, beginning with chicks from one to three weeks old, the rations for some lots were made up without animal food and for others with animal food. The materials were so combined that certain rations were lower than usual in ash, others higher, and still others of medium ash content. To the rations thus made up there were also added varying percentages of glass sand, of fine ground Florida rock phosphate, of ground oyster shell, of bone ash, of sand and Florida rock, of sand and oyster shell, or of bone ash and oyster shell.

In various tests from one twenty-fourth to three twenty-eighths as much sand (grit) was used as of other dry matter fed, and from one forty-eighth to three twenty-eighths as much of the mineral as of the other dry matter. In some rations in which these two classes were combined the added ash elements weighed one-eighth as much as the other dry matter of the rations and the average amount was about one-tenth.

The results show that sand, both in a ration without animal food l in one containing animal food with bone, contributed to a more ient use of the food.

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[a] Compiled from New York State Sta. Bul. 242.

[b] U. S. Dept. Agr., Farmers' Buls. 97, p. 16; 186, p. 23.

The increase in weight was not much greater, but the chicks were healthier, more vigorous, and apparently better prepared than those without sand in their food to make profitable later growth. This was true even in cases where the chicks were running upon sanded floors and so were free to pick up sand as they required it.

This emphasizes the importance of supplying an abundance of grit in the food.

The ground Florida rock phosphate proved of more value as an addition to rations than did sand. When used without sand in two grain rations better results followed, in both efficient use of food and in rate of growth, than when sand alone was added to similar rations. When used with sand in one ration containing animal food but somewhat low in ash and in another ration without animal food, the chicks grew more rapidly and required less food for equal growth than when sand only was mixed with the same foods.

Oyster shells were much less efficient than either sand or ground rock phosphate and did not prove a desirable component of the rations.

In general the results of the experiments emphasize the importance of a plentiful supply of ash for growing fowls.

[They] indicate that even the tiny chicks can make profitable use of such uncommon elements of poultry diet as sand and rock phosphate. The tests must not, however, be regarded as revolutionizing poultry feeding or considered as recommendations for the use of all such materials in ordinary practice. They are, rather, of scientific interest as establishing the necessity for certain elements in the food of poultry. Those elements can be obtained easier, in better combination, and in more palatable form in materials already recommended by our most successful feeders—fine raw or cooked bone. Of these, of some animal meal, of green vegetables, clover or alfalfa, and of good, clean grit, every grower of young chicks should make careful and constant use.

A SUCCESSFUL BROODER HOUSE.[a]

In recent publications of the Connecticut Storrs Station F. H. Stoneburn gives a description of a successful brooder house built at the agricultural college during the fall of 1903, and discusses the importance of properly constructed houses for this purpose and the principles on which they should be constructed.

The importance of properly constructed brooder houses is emphasized by the fact that under modern conditions "everyone engaged in commercial poultry keeping desires to produce a large proportion of his annual crop of chickens at some time of the year other than the natural breeding season of his fowls."

The production of any large amount of this out-of-season stock by natural methods of rearing is, of course, out of the question, and the incubator and the brooder must be relied upon largely. * * *

A brooder building designed for the rearing of chicks during the cold months should embody several distinct features. For the health and well-being of the chicks it should be so constructed that the temperature and ventilation can be absolutely controlled, plenty of sunshine admitted, and enemies of all kinds kept out. For the comfort of the attendant and the economical conduct of the business it should be convenient in every way.

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[a] Compiled from Connecticut Storrs Sta. Bul. 33; Rpt. 1904, p. 172.

While in the brooder house built at the college it was necessary to make special provisions for purposes of instruction and experimental work which would not be necessary or desirable in a house constructed for practical purposes only, it is believed that the plans and methods of construction followed will be suggestive and helpful to the practical poultry raiser.

The house as built is 15 by 30 feet in size, with a 4 by 5 foot extension on the east end. This latter is used as an entry or "anteroom," permitting students and others to pass in and out of the house at will during bad weather without exposing the chicks to drafts. An alleyway 4 feet in width extends along the entire north side, and the rest of the floor space is divided into pens. These are six in number and are 5 by 11 feet in size.

An examination of the accompanying cuts will show that the vital feature of the building is the elevated chick floor, or rather the depressed alley floor, the latter being 3½ feet below the former. (Fig. 2.) This arrangement secures several advantages. It enables the attendant to care for the brooders and feed the chicks without the constant stooping required where the brooders are operated upon the floor in the usual manner. Further, it reduces the inclosed air space by fully one-third, effecting a corresponding saving in the amount of heat required to maintain a given temperature. It also places the chicks nearer the ceiling—the warmest part of the room—thus giving them the benefit of all the available warmth. Repeated tests in the house under discussion demonstrated that in cold weather the temperature at the level of the alley floor is 14° lower than at the chick floor, but 3½ feet above. And, finally, the amount of side wall exposed to the weather is reduced nearly one-half, quite a consideration in wind-swept positions. The disadvantage of the plan becomes evident only when it is found necessary to enter the pens for any purpose. It is inconvenient because of the necessary climb to enter the pen and the confined space in which to do the work. But it has been found unnecessary to get into ɪe pens except on rare occasions, so this is not a serious drawback.

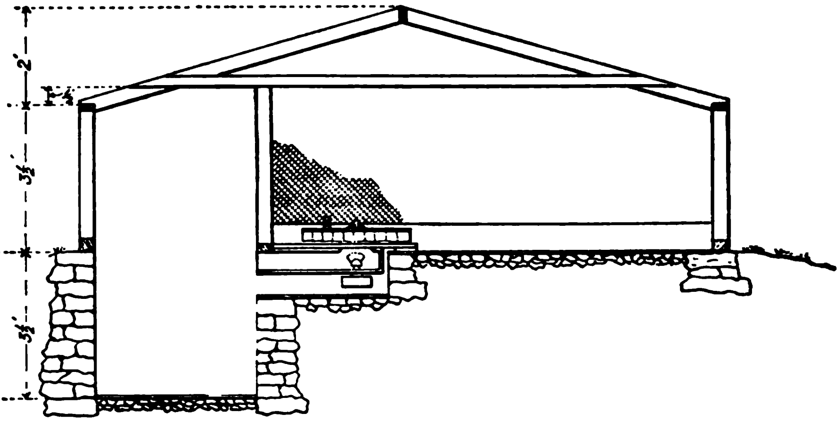

FIG. 2.—Cross section of brooder house.

The site selected for this house is a knoll sloping slightly to the north and abruptly to the east. The alley was formed by digging a trench of the required depth along the north side of the site of the proposed structure. Parallel stone walls 4 feet apart were then laid in this trench and carried to a height of 3½ feet. These were joined by a wall of the same height at the west end, the east end being reserved as a doorway. When laying the wall on the south side of the alley, provision was made for three lamp pits, each 2½ by 5 feet and 1 foot in depth, as indicated upon the plans. Each pit accommodates the heaters of two brooders. (Figs. 3 and 4.)

The rest of the foundation is a simple wall varying in height according to the slope of the land, but carried to the same level as the alley walls. Finally the entire floor was cemented, including the bottoms of the lamp pits, the cement in the chick pens being at the level of the top of the foundation walls.

Because of the small size of the building the frame is constructed entirely of 2 by 4 inch material, except the sills, which are 4 by 4 inch. The walls are 3½ feet in height. The roof is an even span, with a rise of 2 feet. The rafters are tied with collar beams which are spiked on level 7½ feet from the alley floor. The entire frame is covered with seven-eighth inch matched boards, with one-ply Flintkote upon the roof and Swan's extra heavy felt upon the sides. This gives an absolutely wind-proof structure. Eave troughs are required to carry from the roof the water which might otherwise make its way into the building.

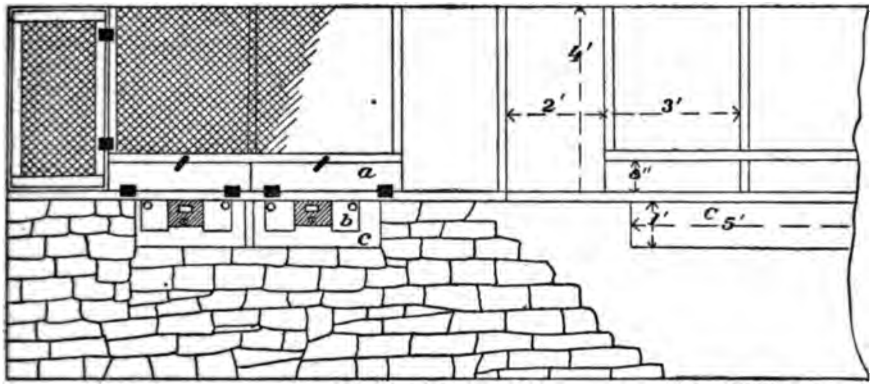

Fig. 3.—Section of brooder house showing south side of alley: *a*, clean-out door rear of brooder; *b*, heater; *c*, lamp pit.

The interior is lathed and plastered with fireproof asbestic plaster. By carrying the plaster across on the collar beams an attic is formed which is of great value in controlling the temperature, preventing direct radiation through the roof. A large sliding ventilator opens into this attic through the ceiling above each pair of chick pens, and in each gable doors are placed, opening into the attic from outside. These are regulated according to the weather. This forms a decidedly effective ventilating system, which is entirely under control.

In the south side of the building are six windows, one for each pen, each a single sash with six panes of 10 by 12 inch glass. These windows are hinged at the bottom and swing inward, being controlled from the alley by cords. At the west end of the alley another window of the same size is placed. This lights the alley thoroughly, which is very desirable, particularly on dark winter days. Chick doors are 6 by 7 inches in size, and are also operated by cords. (Figs. 5 and 6.) The construction of pen partitions is so fully illustrated by the cuts that no further explanation seems necessary. The door is made nearly as wide as the alley, to permit the easy passage of wheelbarrows for cleaning.

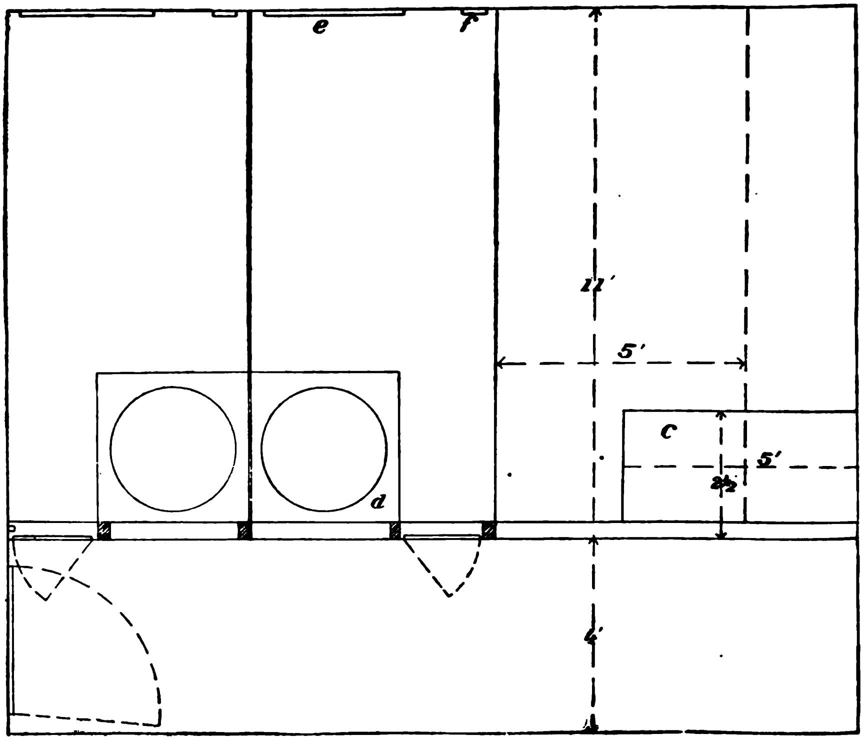

Fig. 4.—Plan of brooder house: *c*, lamp pit; *d*, brooder; *e*, window; *f*, chick door.

The brooders were constructed by the college carpenter, using the metal parts of Peep o' Day brooders. They consist simply of the heaters and hovers mounted upon platforms, no sides or top being required. Because the heaters are suspended in the lamp pits, the floors of the brooders are elevated but 2 inches above the floors of the pens, which enables the chicks to enter the hovers without climbing the usual bridge. The pen floors are kept covered with 1 inch of sand and more or less fine litter, such as chaff, cut straw, etc.

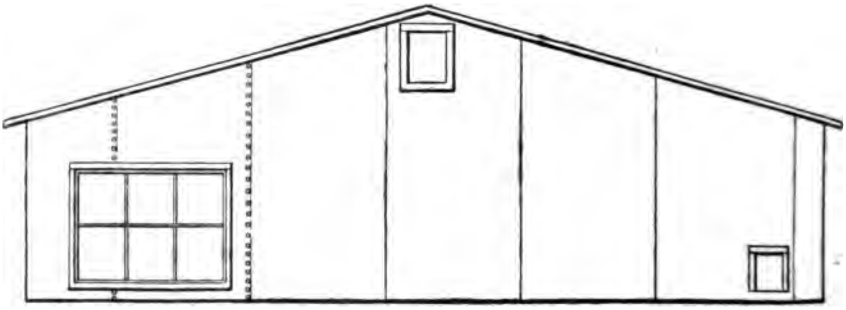

Fig. 5.—West elevation of brooder house.

In ordinary weather the six lamps maintain the temperature sufficiently high, but an auxiliary heater is supplied for use in extreme cold. This is a stove placed near the west end of the alley, and a small fire in it will keep the building sufficiently warm at any time.

For the needs of the practical farmer or poultry man some slight changes might be made in the above plan. The alley could be reduced to 3 feet in width, and still be large enough to accommodate one attendant. The length of the chick pens might be reduced 1 or 2 feet, thus making the building narrower. The depth of the alley might be made 3 feet instead of 3½ feet, and the sides made of heavy plank instead of masonry. The cement floor could be replaced with an earth floor, provided rats could be repelled. The entry extension could be dispensed with. For ordinary use in southern New England the wall might be satisfactory if constructed of two thicknesses of inch boards with paper between. All of the above changes would result in a financial saving so far as the first cost of the building is concerned, but, excepting the reduction in width of alley, they would also cause a decreased efficiency.

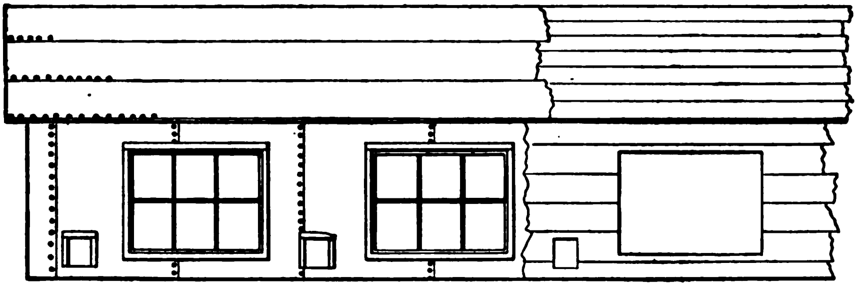

FIG. 6.—South elevation of brooder house.

CAMEMBERT CHEESE MAKING IN THE UNITED STATES.[a]

Of the many highly prized types of European cheese only a very few have been made with any great degree of success in this country. This is particularly true of the soft cheeses, the importation of many of which is made difficult by the brief period in which they remain in a marketable condition.

With a view to developing a new industry in the United States the Connecticut Storrs Station and the Dairy Division of the Bureau of Animal Industry of this Department have been studying in cooperation the manufacture of Camembert cheese, a type of soft cheese considered well adapted to home manufacture.

As regards the distinction between the hard and soft types of cheese it may be said that in making the hard cheeses, of which Cheddar, Swiss, and Edam are well-known types, the curdled mass is cut into small pieces to allow much of the whey to separate from the curd and is often heated to further this separation. High pressure is then employed to force out more of the whey. The resulting curd ripens slowly and is not ready for market for some months. In making the soft cheeses, of which Camembert, Brie, Limburger, and Neufchatel are examples, the curdled mass is allowed to drain naturally and is not subjected to heat or pressure. Soft cheeses, therefore, contain a large amount of water, ripen in a few weeks, developing strong flavors and odors, and remain in good condition only a very short time.

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[a] Compiled from Connecticut Storrs Sta. Bul. 35.

In the investigations which have been carried on in Connecticut it is reported that soft cheese of the Camembert type has been made which has been pronounced by experts to be identical with the best imported cheeses. In undertaking this work no serviceable description of the manufacture of Camembert cheese as practiced in Europe was found available, the process evidently being held as a trade secret. The effort was therefore made to discover the principles involved and then to develop practical methods.

So far only a preliminary report has been made and this deals mainly with the agents concerned in the ripening process. It is believed that the first change affecting ripening is the souring of the curd by lactic-acid bacteria, following which the curd is softened and the flavor developed by two species of mold.

Inasmuch as cheese of the Camembert type can be made by using pure cultures of these organisms, it is considered possible to control the ripening to such an extent as to produce a much more uniform product than has been done. The manufacture of first-class Camembert cheese in America is believed to be perfectly practicable. The method of manufacture is to be described in a later bulletin. Meanwhile it is to be borne in mind that these investigations are still incomplete, and that further work will be required in confirming the results so far obtained and in applying them in practice before this industry can be considered as securely established.

PREVENTION OF SWELLING IN CANNED PEAS.[a]

H. A. Harding and J. F. Nicholson, of the New York State Station at Geneva, report experiments carried on in a local cannery which had suffered serious loss from "swelling," due to a very resistant form of bacteria, which show that heating 2-pound cans to 240° F. for thirty minutes will destroy this germ, "the most resistant so far known in pea canning," and prevent "swelling" without affecting the quality of the goods enough to hurt their sale.

Like results obtained by the Wisconsin Station have been noted in an earlier bulletin of this series.[b]

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[a] Compiled from New York State Sta. Bul. 249.

[b] U. S. Dept. Agr., Farmers' Bul. 73, p. 28.

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U. S. DEPARTMENT OF AGRICULTURE.

COOPER MEDIC
COLLEGE
San Francisco, C

FARMERS' BULLETIN No. 226.

THE RELATION OF COYOTES TO STOCK RAISING IN THE WEST.

BY

DAVID E. LANTZ, M. S.,
Assistant, Division of Biological Survey.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF BIOLOGICAL SURVEY,
Washington, D. C., May 20, 1905.

SIR: I have the honor to transmit herewith for publication in the series of Farmers' Bulletins a report on The Relation of Coyotes to Stock Raising in the West, prepared by David E. Lantz, assistant. The report contains the substance of a paper recently published as Bulletin No. 20 of the Biological Survey, but the matter is of such direct importance to the sheep industry that it seems desirable to give it the wider circulation of a Farmers' Bulletin. If, as seems probable from the evidence submitted, the sheep ranges of the West can be inclosed with coyote-proof fencing at moderate cost, the expensive method of herding may be done away with and the sustaining capacity of the lands thereby greatly increased.

Respectfully,

C. HART MERRIAM,
Chief, Division of Biological Survey.

HON. JAMES WILSON,
Secretary of Agriculture.

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THE RELATION OF COYOTES TO STOCK RAISING IN THE WEST.

INTRODUCTION.

From early days until the present time the ranchmen of the Western States have suffered serious losses through the depredations of wild animals. Live stock of all kinds, more particularly sheep, are subject to the attacks of bears, panthers, and wolves, especially the small prairie wolves known as coyotes.[a] These animals are generally distributed from the central Mississippi Valley to the Pacific coast, and from Costa Rica on the south to northern Athabasca on the north. In this vast range occur at least a dozen species, differing from one another in size and habits. Few of them approach the gray or timber wolves in size, yet all are larger than the largest of the North American foxes. The larger species are the more injurious to live stock; the smaller feed more commonly on wild mammals and thus are less injurious, and sometimes positively beneficial, to agriculture.

FIG. 1.—Coyote.

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[a] "Coyote" is the Spanish name for these animals and serves to distinguish them from the larger gray or dusky wolves that occur in parts of the same range.

The present paper deals with the group as a whole and is confined to a discussion of the economic relations of coyotes in general to the stock interests of the West, and the best means of protection from their depredations.

The Biological Survey is engaged in an investigation of the food habits of all our birds and mammals, in the course of which the coyotes have been studied whenever possible. Some experiments have been made with a view to protecting stock from coyotes, from which it seems probable that fencing, proof against both dogs and wolves, may be erected at a moderate cost. Further tests will be made in the near future.[a]

GENERAL HABITS OF COYOTES.

Coyotes are abundant in most parts of their range, except in the North and in thickly populated sections, where waste lands are scarce. Unlike the larger wolves, they seem not to have suffered through contact with the advancing tide of settlements in the West, so that in many sections they are now practically as numerous as in pioneer days.

The plains east of the Rocky Mountains and the higher plateaus of the Great Basin west of the mountains are especially adapted to the needs of the coyote. Cultivated areas are small; stock ranges are extensive; tall bunch grass, weeds, cactuses, and sagebrush afford good hiding places; the smaller native mammals are abundant, and when these natural resources of the country fail the introduced farm animals afford a plentiful supply of food.

In the State of Kansas warfare against coyotes has been long continued and has been stimulated in most of the counties by the moderate bounty of $1 per animal killed. Statistics show that conditions have been reached where there is but little fluctuation from year to year in the total amount of bounty paid. At the present time nearly 20,000 coyote scalps per year are presented for bounty in the State. A dozen Western States have had similar experiences in dealing with the same pests without materially diminishing their numbers.

While in general denizens of the higher open plains, coyotes are found also on the low tropical coasts of Mexico and Texas and in the higher mountain ranges of the interior. In the northern and northeastern parts of their range they inhabit partially wooded country, and even on the plains they are partial to broken and hilly sections.

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[a] Correspondence with persons interested in this subject is invited. It is hoped that farmers and ranchmen throughout the West who have had personal experience as to the efficiency of any form of fence as a protection against coyotes and other wild animals will write fully as to such experience. All such correspondence should be addressed to the Division of Biological Survey, U. S. Department of Agriculture, Washington, D. C.

Coyotes breed once a year. The mating season is late in January or early in February. The period of gestation is about sixty-three days. The young are produced in dens and number from four to eight or even more. The dens are usually enlarged from those made by badgers or smaller animals, and are often among rocks or in washed-out places along banks of streams. Probably at times they are made entirely by the coyotes. They are rarely far below the surface, but sometimes of considerable extent, and with two or more openings. Little attempt is made to provide nests for the young. In the Central West these are born early in April, and usually may be heard in the dens during May. In June they come out to play around the mouths of the burrows, which are finally deserted during July. By August 1 the young are left by the parents to shift for themselves.

In the earlier descriptions the prairie wolves were usually said to hunt in packs. Lewis and Clark, Say, Richardson, and others so reported, but the Prince of Wied met them only singly. It is probable that they hunt in numbers only when the quarry is large, as in the case of deer and antelope, and as many as three have been known to pursue a single jack rabbit.

FOOD OF COYOTES.

Coyotes feed chiefly upon animal matter, but when such food is scarce they freely eat peaches, apricots, grapes, and other fruits, and even melons, usually destroying more than they eat. In certain areas they feed largely on juniper berries, manzanita berries, and the fruit of the prickly pear. They eat also insects, though perhaps only occasionally.

The animal food ranges from the larger hoofed mammals to the smallest rodents, and includes also birds, reptiles, fish, and crustaceans. Horned toads and other lizards are eaten, and, on the low, tropical coast of eastern Mexico and Texas, coyotes have been seen searching the beach for crabs, fish, and turtle eggs.

BENEFICIAL FOOD HABITS.

Coyotes destroy many injurious species of mammals, and in this way are of positive benefit to farming interests. The various species of jack rabbit are often included in their diet, and the smaller rabbits are habitually eaten. The constant warfare of the coyote upon these rodents has much influence in keeping down their numbers, and the growing abundance of rabbits in some sections of the West has been attributed to the destruction of coyotes as the result of high bounties offered for them.

The various species of prairie dogs also are a staple coyote food.

The coyote usually captures them by hiding behind clumps of weeds or bunches of grass at some distance from the burrows, and when, in feeding, the unsuspecting rodent approaches near enough a few leaps enable the coyote to capture it. It is probably the fear of the coyote that causes the prairie dogs to crop off all the tall growing grass and weeds near their burrows.

In addition to rabbits and prairie dogs the food of the coyote includes rice rats, kangaroo rats, wood rats, ground squirrels, woodchucks, pocket gophers, chipmunks, and pocket mice. All of these are harmful to agriculture, and the coyote in preying upon them performs a valuable service to man. This service is not spasmodic, but lasts throughout the year and throughout the life of the coyote, and has an important influence in helping maintain the "balance of nature."

The coyote is useful also as a scavenger. In the prairie country, especially in winter, it comes into towns at night searching for garbage. Here it finds remnants of meat from the table, offal, and similar prizes. When hungry it rejects no animal food, not even carrion. The slaughterhouses near the towns are favorite feeding places, and the animals are often shot there. On the ranges they soon consume dead horses and cattle, leaving the bones clean.

INJURIOUS FOOD HABITS.

Considerable game is destroyed by coyotes, including quail, grouse, and wild ducks, and their eggs.

Formerly, when deer and antelope were abundant, they were frequently run down and captured by coyotes. To accomplish this the wolves hunt in packs of two or more, taking turns in chasing the victim selected. Their prey runs in wide circles, enabling the wolves to keep fresh until it is exhausted.

The coyote kills hens, ducks, geese, and turkeys. Its usual method of capturing them in daytime is to lurk behind weeds or bushes until the fowls are within reach. Turkeys, which range far afield in search of grasshoppers and other insects, are frequent victims. At night the coyote captures poultry from the roost unless care is taken to guard against its entrance. A correspondent of the Biological Survey wrote from Rexburg, Idaho, that one neighbor lost 60 chickens and another 30 in one night by coyotes. A correspondent in Mayer, Ariz., wrote that he had lost about a hundred chickens by coyotes, but that, although they destroyed poultry, he believed them to be beneficial, as they kept down the rabbit pest.

In approaching ranch buildings, either by day or by night, the coyote comes from the leeward side and with great caution; but once tisfied that no danger lurks in the shadows, it becomes very bold

One has been known to make a dash into a dooryard, seize a chicken by the neck, and make off with it before anyone could interfere. In the same way the animal visits pig pens and takes young pigs from the sow.

Few of the mammals of the farm are exempt from the raids of coyotes. Even house cats roaming far from home in search of mice become victims. A correspondent of Forest and Stream, living in Wyoming, October 7, 1896, states that he had lost four cats in this way within a few months and that it seemed almost impossible to keep them in his neighborhood.

The coyote has been known to kill the young of most farm animals—colts, calves, pigs, lambs, and goats. Colts are seldom killed because the dams can usually protect them. Calves are taken only when the mother cow is feeding at a distance or has gone for water. The coyotes lie watching in the grass until this opportunity comes. Sometimes older animals are killed. Ranchmen in Oklahoma told the writer that in winter yearling cattle in good condition are sometimes killed by coyotes. To accomplish this two or more of them must hunt together, and get the victim separated from the herd.

THE COYOTE'S RELATION TO THE SHEEP INDUSTRY.

The coyote is especially notorious as an enemy of the sheep industry. In many parts of the West sheep raising has greatly languished because of the depredations of wild animals upon the flocks. While some of the injury is caused by the larger wolves, mountain lions, bears, and lynxes, the coyotes are by far the most formidable enemy. They are not only more abundant than the other animals mentioned, but they are present throughout the year, and their depredations are a steady drain upon the resources of the flock owner, comparable in extent to the losses caused by worthless dogs in many parts of the country.[a]

A correspondent writing from Russell, Kans., in 1887, regarded the prairie wolf as the most troublesome of mammals. Its raids upon sheep and lambs were so frequent that flocks could not safely be left alone. Even when the herder was only temporarily out of view a wolf would make a dash into the flock and usually secure a lamb.

In 1888 a flock of some 4,000 sheep was driven through Bozeman, Mont., and night overtook them on the foothills south of that town. During the night coyotes entered the ranks and stampeded the sheep. Many ran over the bluffs, and in the morning sheep, dead and dying, were several feet deep at the foot of the bluffs. Nearly 500 were counted in the pile, and for several days afterward sheep with lacerated ears and torn flanks wandered into barnyards in the vicinity.

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[a] In 1891 the loss from dogs in Ohio was placed at $152,034 and $200,000 in Missouri. (Sheep Industry in the United States, U. S. Dept. of Agric., 1892.)

In parts of the Southwest sheep growers have estimated their losses from wild animals to be 20 per cent of the flocks. The average loss reported from several States is 5 per cent. In nearly all the States the number of sheep has decreased during the past two years, and in the West one of the principal causes is losses from coyotes. At present the business of raising sheep flourishes best in sections where the flocks are under the care of herders. But this system of herding in large flocks results in constantly increasing deterioration of the pastures.

It is evident that the wealth of any State can be materially increased if it is possible everywhere to keep small flocks of sheep. Flocks increase rapidly under favorable conditions and good management, and the cost of keeping is small when herders can be dispensed with. The double product, wool and mutton, usually places the profit of handling sheep above that of cattle or horses. The gains also come oftener, since sheep mature in a year, while cattle and horses require three.

In the region about Seguin, Tex., according to Vernon Bailey, chief field naturalist of the Biological Survey, no sheep are kept, because of the abundance of coyotes. The region is occupied by small farms, mainly 80 to 500 acres, on which cotton, corn, sorghum, and vegetables are the principal crops. While there are few large stock ranches, each farm has abundant pasturage for horses and cattle and can support from 50 to 200 sheep on the surplus pasturage and the weeds that grow up on the farms. The farmers admit the advantage of introducing sheep, but the fear of coyotes deters them from the experiment.

Similar conditions prevail over large areas in many parts of the West. The number of sheep in the United States has been decreasing during the past two years, while the price of wool has been excellent and the demand for mutton steadily increasing. Montana, with an area of 146,000 square miles, leads the States in the number of sheep kept, which is 5,638,967.[a] Yet England, with an area of only 50,867 square miles, has about five times as many as Montana. In Montana sheep are herded in immense flocks; in England every landowner and farmer keeps a small flock.

The advantage of sheep upon the farm as weed destroyers is not usually appreciated in America. The Iowa Agricultural Experiment Station reports that out of 600 species of grasses and weeds, tle are known to eat only 50, horses 82, while sheep eat 550. With abundance of pasturage, favorable climate, good prices for wool and mutton, and increased fertility and productiveness of the soil upon which sheep are grazed, there should be a decided advance in the sheep industry. The chief discouragement seems to lie in the depredations of worthless dogs and coyotes.

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[a] Crop Reporter, U. S. Dept. Agric., February, 1905.

The evil of worthless dogs can be best remedied by a resort to taxation. Dogs should be regarded as property and taxed sufficiently to put all of the dangerous and worthless curs out of existence.

DESTRUCTION OF COYOTES.

The coyote pest presents a serious problem, and various methods of dealing with it have been tried. None of them has been entirely satisfactory, and some have been decided failures. All of them combined have resulted in a partial check to the increase of coyotes in most parts of their range.

USE OF POISON.

Poison has probably killed the greatest number of adult animals, and in parts of Mexico has almost destroyed some of the species, but no such success has followed its use in the United States. Strychnine is the favorite poison, and is, all things considered, the only one suitable for the purpose.

In the use of strychnine, the dry crystals of strychnia sulphate are generally preferred, as the poison in this form is readily soluble. The poison is inserted with a knife in small chunks of meat or in the carcass of some animal left upon the prairie. The meat should be handled as little as possible, and if small pieces are used it is best to distribute it from horseback along trails used by the wolves. The animals are very cunning in detecting and avoiding poisoned meat, and some hunters are successful in allaying their suspicions by burying the bait.

It should be remembered that poisoned baits are as likely to attract dogs as wolves. When poison is to be used the entire neighborhood should be informed, and valuable dogs should be confined until the operations are over and all uneaten baits destroyed.

USE OF TRAPS.

Coyotes are not easily trapped. Some skill and a good knowledge of their habits are requisites for success.. They travel in rather well-defined paths and usually hunt against the wind. Having a keen sense of smell, they easily detect the tracks of man, and if they have had previous experience of traps or guns they are suspicious of danger. In the wildest parts of the country remote from settlement they are more readily trapped. The chances for successful trapping decrease with their familiarity with man, so that there is little probability that the process will ever have much effect on their numbers.

Field naturalists of the Biological Survey usually have experienced little difficulty in securing coyotes in traps. A No. 3 steel trap is generally used. A suitable place is selected along a narrow path or trail and the trap is sunk in the ground level with the surface and concealed with fine grass, leaves, or other material that will harmonize with the surroundings. At the same time care is taken that the material used shall leave the jaws of the trap free to spring clear of the covering.

The trap should be fastened to a bush or stake, or, if these are not available, to a clog. For the last a pole lying on the ground is best, since it may be utilized without moving it or disturbing the surroundings. If the trap is anchored to a bush or small tree the chain must be securely fastened with snap or wire. A stout stake over which the ring will not slip, driven out of sight into the ground, is better. Every part of the trap and chain is covered, and the ground left in as natural and undisturbed condition as possible.

Any kind of fresh meat will do for bait—rabbits and other small rodents are often used, but larger baits seem to be more attractive. It is also of advantage after setting the trap to make a " drag " of the bait for a quarter to a half mile, at the end of a rope from the saddle horn, and finally to fasten it to a bush or stake close to the trap, or cut it in bits and scatter all around the trap, so that not all can be reached by the coyote without walking over the trap. The skill of the trapper and the situation of the trap will determine the best arrangement. The suspicion of the coyote is lessened apparently after following the bloody trail of a well-planned drag.

Before setting the traps many trappers rub their feet and hands on a skin or some strong-smelling meat or carcass to conceal the human odor. Oil of anise or rhodium is sometimes used for the same purpose. Any strong odor is likely to attract the attention of the coyote and allay suspicion. Care must be taken not to spit on the ground or kneel or throw down any clothing in the vicinity of the trap. A good plan is to set a line of traps and leave them for a day or two, and then go the rounds with a horse and drag and bait the traps without dismounting.

HUNTING THE COYOTE.

Many ranchmen find dogs an efficient help in guarding against coyote depredations. For this purpose the small varieties are useless, since the coyotes do not fear them. Beagles and larger foxhounds are too slow. Staghounds, Russian wolfhounds, greyhounds, and their crosses are to be preferred; and at least three are needed to successfully chase and safely kill a coyote. These dogs soon learn to hunt wolves and are seldom known to harm sheep. Ranches on which they are kept are comparatively free from depredations of wild animals, while others but a few miles distant are by no means exempt.

Coyote hunts, in which an entire community engage, have become a popular feature of rural sport in some parts of the country. Such hunts have been held in Kansas, Colorado, Idaho, Oklahoma, and Texas. The method employed depends much upon the local topography and other conditions. Men on horseback, with greyhounds, engage in the sport when the country is open. The chase, as in coursing hares, is straight away, and when the quarry is overtaken the fight is won only by the overpowering numbers of the pursuers.

The writer was present at the second annual wolf hunt in the large Pasture Reserve, near Chattanooga, Okla., which took place November 24, 1904. The area covered by the drive was somewhat over 6 miles square. Over 700 people took part in the sport, either actively or as spectators, and while only 11 wolves were killed the hunters seemed to feel amply repaid for their efforts. Such hunts have the result of decreasing the number of coyotes and also afford a pleasant break in the monotony of frontier life. Their purpose, however, is not admitted to be that of sport, but to kill coyotes.

BOUNTIES.

Activity in the warfare against the coyote has been considerably stimulated by the payment of bounties from the public treasury of the States and counties. Nearly all the States in which coyotes occur have been for years maintaining such bounty systems. In some parts of the West these are supplemented by rewards from stock associations or ranch owners. The bounties from public funds have ranged from 25 cents to $5 for each animal killed, but supplementary payments sometimes make them as high as $15.

The subject of bounties in general has been already discussed by Dr. T. S. Palmer, of the Biological Survey.[a] Doctor Palmer refers to the California coyote act of 1891, which was practically in force only eighteen months, but which cost the State $187,485. As the bounty was $5 per scalp, this represented the destruction of 37,493 coyotes. Kansas, with a county bounty of $1 per animal, succeeds in destroying about 20,000 each year. In addition to the bounty, the pelt of an adult coyote is worth from 50 cents to $1.50, according to its condition. However, most of the killing is accomplished in spring, when the female and her young are dug out of dens and the pelage of the adults is not in prime condition.

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[a] Extermination of Noxious Animals by Bounties. Yearbook U. S. Dept. of Agr., 1896, pp. 55-68.

Doctor Palmer rightly concludes that in practice bounties for the destruction of noxious animals, paid from public funds, are usually objectionable. Probably those upon wolves and coyotes can be best defended. While it is certain that the encroachments of civilization, without the aid of such rewards, would have operated to diminish the numbers of the larger wolves, the observed effect of settlements on the coyote has been different, and bounties undoubtedly have been effective against them in certain parts of the country. Whether the results have been commensurate with the cost is another question. The chief objection to bounties is, after all, that they usually lead to fraudulent practices.

PROTECTION AGAINST COYOTES.

All the foregoing methods of destroying coyotes, even when combined, having failed to greatly decrease their numbers, it is necessary to consider means of preventing depredations upon live stock. If domestic animals can be protected, coyotes will be forced to return to the beneficial occupations of destroying noxious rodents and acting as scavengers.

FENCING AGAINST OTHER WILD ANIMALS.

Fencing as a means of protection against wild animals has for several years been in use in the Australian colonies and in South Africa. In Australia wire nettings are used successfully to keep rabbits, dingoes, and some species of kangaroos out of pastures and crops. In Cape Colony jackals are a great hindrance to sheep and ostrich farming, and the success attending the use of the nettings in Australia led to experiments with them in the South African colony. The results have been satisfactory. While the fencing is expensive, the advantages from its use have more than compensated for the outlay.

Mr. T. T. Hoole, president of the Upper Albany (Cape Colony) Farmers' Association, gives details[a] of ten years' experience wi jackal-proof fencing. He first imported netting 2½ feet wide, b found it insufficient after a few months. He added barbed wires t increase the height, but finally determined on 3-foot netting and fo barbed wires as best adapted to his purpose, which is to incl ostriches, cattle, springboks, and sheep. He has 18 miles of this ki of fencing, while a neighboring stockman has 45 miles built.

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[a] Agr. Jour. Cape of Good Hope, 1904, vol. 25, pp. 560–563.

The cost, including labor, of Mr. Hoole's fence when built of the best materials—sneezewood posts and kangaroo netting—was estimated at £106 (about $500) per mile, but a fence intended for sheep alone could be built for less. Materials and labor are both much more expensive than in the United States and a fence similar to that described by Mr. Hoole could be built in most parts of the West for about $200 to $250 per mile.

Mr. Hoole names the following advantages of jackal-proof fences to sheep growers:

(1) Decreased cost of herding.
(2) Increased value of the wool, amounting to 3 cents a pound.
(3) Increased number of lambs reared.
(4) Increased value owing to early maturity and condition of the stock.
(5) Less liability to contagion from scab.
(6) Reduced death rate.
(7) Additional security of the flock.
(8) Improved condition of pasturage as against deterioration.

The last item alone he regards as more than repaying the entire cost of erection. Under the system of herding on the open veldt it becomes necessary to protect from wild animals by driving the sheep to a kraal for the night. In the vicinity of the kraal the ground is soon trodden bare, and deep parallel paths are worn in the surface. In a few years the torrential rains wash the paths into what are called "sluits"—similar to the "arroyos" of our own Southwest.

In the western part of the United States the practice of keeping sheep in vast herds has resulted in much deterioration of the ranges, due to overcrowding, and the cost of herding has absorbed much of the profits of sheep raising. The process of withdrawing lands for homesteads and the various reservations has diminished the free range and increased the crowding, until flock owners for their own protection have been compelled to purchase lands for range purposes. The day of free pasturage on public lands is fast passing, and with private ownership of ranges fencing must be resorted to to confine the flocks. The additional expenditure necessary to make the fences proof against coyotes would be inconsiderable when all the advantages are properly weighed.

INVESTIGATIONS CONCERNING COYOTE-PROOF FENCING.

If a coyote-proof fence of sufficient cheapness and durability to be practicable can be brought into general use for inclosing pastures, there is no reason why the sheep industry in the West should not be revived and greatly extended. If such a fence should at the same time prove efficient against dogs, the benefit would extend to the whole country and result in an enormous increase of the productive resources of our farms. A coyote-proof fence would prove valuable, even if its use were restricted to corrals and small pastures for ewes during the lambing season.

The writer interviewed a number of farmers in Kansas who have had experience with poultry and farm animals in coyote-infested country. Several of them had for some years been using for corrals and small pastures woven-wire fences, and had found those from 57 to 60 inches high entirely coyote-proof. These fences have triangular meshes and are of sufficient weight to be suitable for all kinds of stock. Such fences, if set with the lower edge on the ground and anchored down where necessary, can safely be recommended as coyote-proof. Their cost, however, is possibly too great to bring them into general use for sheep pastures. Where land is valuable and pastures of the best, they will prove economical, for they have the merit of being both dog-proof and coyote-proof. Dogs, both large and small, that by chance get inside the inclosures are unable to get out, and have to be let out by the gate.

Between these rather expensive fences and the cheapest form that may be found efficient many grades may exist. In experiments to determine the efficiency of any form it is necessary to consider the familiarity of the animals with fences in general. In a new country a very simple fence at first might serve to keep out wolves, but ultimately would prove insufficient.

A writer in the Nor'-West Farmer states that when he first began sheep raising in Manitoba a two-strand barbed-wire fence was a complete barrier to the coyotes, but that in less than two years they became used to it and would go under or between the wires without hesitation. More strands were added without effect, until a woven-wire fence was adopted, which proved satisfactory.

In South Africa three types of fence have been in use for protection against jackals, and each has advocates among the farmers. The cheapest is built of strands of barbed wire placed close together
nd stayed at intervals by light strips of wood fastened to the wires
staples. In the second form the staying is done by light, smooth
e, woven in by machinery, involving more labor in the building.
e third type is that recommended by Mr. Hoole. It is more
ensive, but seems always to have stood the test of use. The
ers have not always been satisfactory, but their advocates claim
the fault has been in construction and not in design. The
ls have entered the inclosures through openings at the ground.
J. H. Clarke, of Laytonville, Mendocino County, Cal., for
years has succeeded in fencing coyotes from his sheep range.

In a letter to the Chief of the Biological Survey, dated March 4, 1905, he describes the fence and relates his experience:

> The fence, inclosing nearly 4,000 acres, consists of redwood pickets 6 feet long driven into the ground 1 foot and leaving spaces or cracks not over 4 inches wide; posts 8 feet long and driven 2 feet, projecting 1 foot above the pickets; two barbed wires stapled to the posts 5 inches above the pickets and the same distance apart. These should be on the outside of the posts. The pickets are driven evenly by using a slat as a guide at the bottom and a line at the top. One barbed wire is placed at the bottom on the outside to prevent digging. The pickets are fastened to a No. 9 cable wire with a No. 13 wrapping wire. The posts are set 12 feet apart, or less, according to the surface, at top and bottom of each rise or indentation.
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> Where gulches or small streams are crossed boxes and gates are put in. Where larger streams are encountered a dam is first put in and the gate so swung as to rest on or against the dam head in the dry season.
>
> The cost of construction varied from $320 to $400 per mile. Galvanized wire was used, and of the barbed the thickest-set four-pointed wire obtainable. If four-point wire could be had, with sharp points set not over 2 inches apart, the top wire might be dispensed with.
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> While this fence was begun in 1897, it was not finished until three years ago. It was partly experimental at first, and at the end of the second year only that portion of the range used for lambing was inclosed with a coyote-proof fence. We do not know that a coyote has ever scaled or jumped it. A very large coyote that got in through an accidentally "propped" floodgate, though chased by dogs all day, could not be made to jump out, even when cornered. Considering the steep, wild, and broken nature of the country, with several "slides" in the fence that could not be avoided when building, and which move and displace the fence during hard storms, it is not surprising that a few coyotes have gotten in. Fortunately, partition fences have aided in the capture of these before much damage was done. Two obstacles are encountered in keeping up this fence—trespassers, who cut or break a picket to get through, and slides.
>
> Coyotes are very persistent, and when they see young lambs on the opposite side will follow the fence for miles, trying to find a hole. * * * None have gotten in this season.
>
> When we began to fence against them, the coyotes were literally driving sheep out of the country. * * * Horses and cattle have taken their places, but return less than half the profit sheep did prior to the coyote's inroads. Excessive rains in winter and irregularity of landscape preclude the practicability of close herding. With us it was either abandon sheep or fence the pest out. Fortunately we adopted the latter.

While the fence used by Mr. Clarke is expensive, the complete success of his experiment is significant. In most parts of the West woven wire would be cheaper than pickets and would require less labor in its erection. Where the land is as uneven as that just described, the use of woven wire may be impracticable.

Mr. D. W. Hilderbrand, of California, who has built coyote fences for ranchmen in the San Joaquin Valley, recommends a 3-inch mesh woven wire fence 36 to 40 inches in height, with two barbed wires above, 5½ inches apart, and one at the bottom. He recommends that the posts be set 20 to 30 feet apart.

Under instruction from the Chief of the Biological Survey, the writer spent several weeks in the field during October and November, 1904, making such investigations as were possible during the limited time at his disposal. For the purpose of testing the ability of coyotes to pass over or through fences a unique experiment was made. The place selected was Chattanooga, Comanche County, Okla. South of the town lies the great Pasture Reserve, a large area practically without fences to interfere with the chasing of wolves. Coyotes were abundant and the cowboys skilled in their chase, so it was not difficult to procure the needed animals in an uninjured condition.

The experiment was made with all the forms of fence that could possibly be obtained or built with the limited resources of a new country. A long lane was first built, with sides 7 feet high, made with poultry netting of a small mesh. Fourteen cross fences of heights from 30 to 66 inches and of various designs were built at intervals along the lane. They were so arranged that the coyotes, introduced at one end of the lane, should have presented to them gradually increasing difficulty in passing the fences. Two coyotes were released singly into the lane, and their progress and methods of passing the cross fences were carefully noted.

The coyotes ran with their noses close to the ground and seemed to have no knowledge of jumping. Neither of them succeeded in getting over a fence more than 36 inches in height. The method was one of climbing rather than of jumping. All attempts to pass the obstructions began with efforts to get the muzzle through openings. If the entire head could be thrust through and the space was wide enough for the shoulders to pass, the whole wolf was able to follow. Both went through rectangular openings 5 by 12 inches and 5 by 8 inches, but the larger animal failed to pass a mesh 5 by 6 inches. The smaller animal went through an opening 4 by 12 inches and another 5 by 6 inches. Had these openings been triangular in form the animal could not have passed through.

In the experiments the animals, under excitement, were attempting to escape from confinement. In the judgment of the writer, the experiments are insufficient to determine what a coyote would do if the conditions were reversed and, impelled only by the stimulus of hunger, it were attempting to enter an inclosure built of these fences. The barriers would surely be far more formidable. Experiments with certain types of fence, inclosing sheep, in a country where wolves are numerous would be far more conclusive in establishing a safe basis for practical recommendations to farmers.

SUMMARY OF CONCLUSIONS REACHED.

The following conclusions are drawn from the experiments and from other data now available:

(1) Prairie coyotes will not willingly jump over a fence above 30 inches in height.

(2) They will readily climb over fences built of horizontal rails or crossbars, especially in order to escape from captivity.

(3) Barbed wires do not deter them from crawling through a fence to escape. Whether they will go through a closely built barbed-wire fence to attack sheep or poultry is still an open question.

(4) Woven-wire fences should have meshes, when rectangular, less than 6 by 6 inches to keep out coyotes. For such fences triangular meshes are much better than square ones.

(5) In fencing against coyotes with woven fences care must be used to see that there are no openings at the ground through which the animals can force themselves, since they are more likely to crawl under a fence than to jump over it.

(6) It seems reasonably certain that a fence constructed of woven wire with a triangular mesh not over 6 inches across and having a height of 28 to 42 inches, supplemented by two or three tightly stretched barbed wires, would prove to be coyote-proof. It is difficult to make exact estimates of the cost. Woven fences differ in weight, price, and durability, and freight charges on materials depend on the distance from distributing points. The cost of posts and labor varies much. An estimate based on so many variable factors is of little value, but an average of $200 per mile would probably allow the use of the best materials.

Further experiments with wire fences will be made by the Biological Survey in cooperation with sheep growers in the West, and the results will be given to the public as early as practicable.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.:

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 227.

Experiment Station Work,

XXX.

Compiled from the Publications of the Agricultural Experiment Stations.

TOP-DRESSING GRASS LAND.
EXTENSION OF CORN GROWING.
PEANUTS FOR FORAGE.
WINTERKILLING OF FRUIT TREES.
CRANBERRY CULTURE.
LIME-SULPHUR-SALT WASH.
DESTROYING PRAIRIE DOGS.
CLEAN MILK.
POULTRY HOUSES.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.

A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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[d] Acting director.

EXPERIMENT STATION WORK.

ted by W. H. **Beal** and the Staff of the Experiment Station Record.

iment Station Work is a subseries of brief popular bulletins compiled e published reports of the agricultural experiment stations and kindred ons in this and other countries. The chief object of these publications seminate throughout the country information regarding experiments at rent experiment stations, and thus to acquaint farmers in a general h the progress of agricultural investigation on its practical side. The herein reported should for the most part be regarded as tentative and ve rather than conclusive. Further experiments may modify them, and ce alone can show how far they will be useful in actual practice. The the stations must not be depended upon to produce "rules for farming." apply the results of experiments to his own conditions will ever remain lem of the individual farmer.—A. C. **True**, Director, Office of Experi-ations.

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FIG. 1. Two sections of curtain-front poultry house
2. Interior of one section of curtain-front house, showing also trap nests in one corner

EXPERIMENT STATION WORK.[a]

TOP-DRESSING GRASS LAND.[b]

Grass lands require special fertilizer treatment. After the meadow is been established on land of good fertility and in good tilth and ops of hay are removed each year, the original supply of plant food diminished and the productiveness of the meadow necessarily creases. In order to maintain its profitable yielding capacity the pply of plant food must be kept up through fertilization. The ethod of applying fertilizers presents some difficulties which are not countered in fertilizing the soil for most of the other crops. The rass remains upon the land continuously for a series of years and here is no opportunity for plowing under green manure or applying arnyard manure or commercial fertilizers and incorporating the ame into the soil from the time one crop is removed until the succeeding one is put in, as can be done in the culture of annual crops. Furthermore, the coarser undecomposed material of barnyard manure which remains upon the meadow is likely to be raked up with the hay, which is a decided disadvantage, and the manure sometimes also has the effect of reducing the quality of the grass by causing a rank growth and by the introduction of weeds. The use of commercial fertilizers on meadows has the advantage of leaving the barnyard manure produced on the farm available for other crops, to which it can be more readily and satisfactorily applied. If barnyard manure is to be used on a meadow it should be applied as a uniformly fine and well-rotted compost.

For the different reasons given, and also on account of the greater availability of the plant food they contain, certain commercial fertilizers are better adapted to top-dressing grass lands than barnyard manure. The farmer must know, however, the kinds and quantities of fertilizers best suited for this purpose, at what time the application should be made, and whether under ordinary conditions he may expect a profitable return. These questions have been studied by the Rhode Island Station in an experiment extending over a period of six years, and the results obtained are here briefly summarized.

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[a] A progress record of experimental inquiries, published without assumption of sponsibility by the Department for the correctness of the facts and conclusions ported by the stations.

[b] Compiled from Rhode Island Sta. Buls. 57, 71, 82, 90, 10 [illegible]

The experiments were begun in 1899 on three plats, numbered 17, 19, and 21. Since 1893 these plats had been devoted chiefly to the growth of leguminous crops and had received annually 180 pounds of muriate of potash and a quantity of phosphoric acid approximately equivalent to an application of 1,200 pounds of acid phosphate containing from 13 to 14 per cent of available phosphoric acid. During this same period plats 19 and 21 received each year 150 and 450 pounds of nitrate of soda per acre, respectively, while plat 17 received no nitrogen and had probably not received this element for from 15 to 20 years. In 1897 all plats were treated with 1 ton per acre of slaked lime. In 1898 7.5 pounds each of common red clover and redtop and 15 pounds of timothy per acre were sown, with barley as a nurse crop. The yields of hay obtained in 1899 were as follows: Plat 17, 5,075 pounds; plat 19, 6,300 pounds, and plat 21, 6,913 pounds per acre. The hay from the no-nitrogen plat consisted almost entirely of clover, while the crop from the other two plats was largely redtop and timothy. The results of this season indicated that large crops of grass require considerable quantities of immediately assimilable nitrogen applied early in the season, and that good crops of clover can be grown on limed land without supplying nitrogen in the form of commercial fertilizers. Allowing 20 per cent for shrinkage in the hay and estimating the value of the different crops at from $9 to $15 per ton, plat 17 gave a difference of $6.09 per acre over the cost of the fertilizer applied; plat 19 a difference of $14.34, and plat 21 of $19.62.

In 1900, soon after the grass started to grow, all plats received the regular dressing of potash, phosphoric acid, and nitrogen, but in 1901 the fertilizer application per acre was changed to 807.5 pounds of acid phosphate, containing 130 pounds of phosphoric acid; 200.52 pounds of muriate of potash, furnishing 100 pounds of potash, and 133.52 pounds of nitrate of soda on plat 19 and 400.56 pounds on plat 21, supplying 21 and 63 pounds of nitrogen, respectively.

Throughout the entire experiment plat 17 received no nitrogen; plat 19 a one-third ration, and plat 21 a full ration. The results obtaine with the modified application emphasized the need of properly adjusting the quantities of the different elements given in the fertili application. The reduction of the nitrate of soda from 450 to 400. pounds and of the acid phosphate from 1,200 to 807.5 pounds and th increase of the muriate of potash from 180 to 200.52 pounds reduc the cost of the application and resulted in higher profits. The treatment of the plats in 1902 was essentially the same as the year befo with the exception that the quantity of muriate of potash was rais to 303.26 pounds, furnishing 150 pounds of actual potash per acre. During the last two years of the six-year period the fertilization was the same as in 1902. The principal data secured in the experiment are shown in the following table:

Results obtained in a six-year fertilizer experiment on grass land at the Rhode Island Station.

Year.	General application.		Plat 17, no nitrogen.		Plat 19, one-third ration.		Plat 21, full ration.	
	Potash.	Phosphoric acid.	Hay per acre.	Value of crop over fertilizer.	Hay per acre.	Value of crop over fertilizer.	Hay per acre.	Value of crop over fertilizer.
	Pounds.	*Pounds.*	*Tons.*		*Tons.*		*Tons.*	
1899	88.31	164.1	2.54	$6.09	3.15	$14.34	3.46	$19.62
1900	90.38	191.1	2.00	13.42	2.80	20.37	4.10	30.40
1901	100.00	130.0	1.65	12.13	2.78	23.97	4.70	40.70
1902	150.00	130.0	1.48	7.44	2.43	16.52	4.10	32.74
1903	150.00	130.0	1.64	7.70	1.85	9.38	3.83	27.81
1904	150.00	130.0	1.25	3.60	2.05	10.71	4.07	30.36
Average			1.76	8.40	2.51	15.88	4.03	30.27

The results for the six years show that without nitrogen an average of 1.76 tons, with one-third the full application 2.51 tons, and with the full application of nitrogen 4.03 tons of field-cured hay was secured per acre. A satisfactory stand of timothy was maintained for the six years only on the plat which received the full ration of nitrogen, and this plat also produced the highest market grade of hay. It was found that where the full ration of nitrogen was given a ton of field-cured hay removed from the soil 32 pounds of potash, 13.1 pounds of nitrogen, and 6.5 pounds of phosphoric acid. In each of three years in which determinations were made more nitrogen was supplied in the full ration than was removed by the crop. With potash and phosphoric acid alone the value of the crop per acre exceeded the cost of the fertilizers on an average per year by $8.40; with one-third the full nitrogen application, by $15.88, and with the full application of nitrogen by $30.27. Determinations of the shrinkage in barn-curing hay showed that it ranged from about 13 to 19 per cent.

For three years an experiment was conducted on two plats to determine the best quantity of phosphoric acid to be applied per acre. An average annual yield of 4.16 tons of barn-cured hay was obtained where 40 pounds of phosphoric acid was applied, and 4.54 tons of field-cured hay where 60 pounds was used. A potash test was conducted on the same plan. The average annual yield of field-cured hay where 150 pounds of potash were used was 5.1 tons per acre, and where 200 pounds were used 5.3 tons.

The data derived from the experiments show that good financial returns may be obtained from grass culture with the use of commercial fertilizers alone. The use of 400 to 500 pounds of acid phospha and 300 to 350 pounds of muriate of potash and nitrate of soda p acre, applied from April 15 to 25, is suggested as being best adapt for use as an annual top dressing on grass lands where a good sta of timothy and redtop already exist, where a too great degree of s acidity does not prevail, and where commercial fertilizers only a used.

EXTENSION OF THE CORN-GROWING AREA.[a]

Several of the experiment stations, especially those of the Nort western States, have given much attention to the question of the e tension of the limits of successful corn culture, and have shown th by careful selection of varieties and modified methods of cultu suited to the conditions this crop may be successfully grown regions heretofore considered entirely unsuited to corn culture. Th work is proving of great value to those regions in increasing t available supply of food and forage.

In view of the increasing interest in corn growing in Idaho, G. Crosthwait, of the Idaho Experiment Station, has prepared a bull tin stating the need of extension of corn growing in Idaho and gi ing brief directions regarding methods of culture suited to tha region. Some of the reasons why an extension of corn culture i Idaho is recommended are stated as follows:

> (1) It is needed in our rotations. Wheat can not be raised on the same groun continuously. Many farms in Idaho are becoming less fertile than formerl from this very cause, and a change must be made. A systematic and ration rotation should be practiced. Wheat should be followed by some rotation cro such as clover, and this by corn. Wheat could then again be sowed and th rotation repeated. Each crop might be raised two years. This makes a simpl and effective rotation, and one that would greatly benefit most of our lan (2) Corn would be a very valuable addition to our feeding operations for wor ing animals, fattening animals, and dairy animals. (3) It is also needed fo human food. Corn is being shipped in for grinding into corn meal. (4) In th minds of those who have studied the matter there is no longer any doubt tha corn can be profitably raised in many sections of Idaho. The average yield i the State in 1903 was 34.5 bushels per acre, 1 bushel higher than that of an other State in the Union.

The following directions regarding methods of culture suited t Idaho and regions with similar conditions are given:

Selection and test of seed.—If seed must be purchased, it should be that whic has been raised under climatic conditions similar to those under which the cro is to be grown. The seed having been decided upon, the best ears should b carefully selected. As a rule, average-sized ears with deep grains closely se upon a small-sized cob should be selected.

Take a few grains from different parts of the ear and plant them in a box o soil, sand, or sawdust, setting the box in a moderately warm place. If e grains taken from any ear do not sprout in a week, it is better to discard ear.

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[a] Compiled from Idaho Sta. Press Bul. 5, n. ser.

paration of seed bed.—Next in importance to the selection and testing of if. indeed, it is not of equal importance, is the preparation of the soil for reception of the seed. Certain it is that no subsequent efforts can atone ack of preparation before planting. Where it can be done it is usually to plow the ground in the fall. In this way, the soil is in a condition to rb the rainfall instead of allowing it to run off. The frosts of winter and action of the atmosphere tend to crumble the soil and to cause the organic ter in the soil to disintegrate and become available as plant food. Many mies of the corn are destroyed, such as cutworms and grubworms. The may be worked earlier in the spring as the surface is drier than that of not plowed, although there may be more water in the lower layers of soil. over crop sown in the fall after fall plowing and turned under in the spring beneficial. Rye is a good cover crop and may be grazed when the ground not too soft. (A heavy clay should not be plowed in the fall, if the winter ins are excessive, as the soil will run together and become compact.) As rly in the spring as the ground is dry enough to work, the soil should be sked and harrowed to retard the evaporation of the moisture. The soil ould be kept in good condition until planting time, no crust being allowed to main, as it will permit the moisture to escape. If the soil is properly cultiated there will be no clods to contend with and the seed bed will be soft and ellow for the reception of the seed. A quick germination and a rapid growth re thus assured.

ime and manner of planting.—It is best to plant as soon as danger of frost is ver, especially in those parts of the State where the frosts of autumn come arly. It is better to risk a spring frost than one in the fall, as the corn can ecover from a rather severe frost in the spring, if the nodes or joints are not bove the surface. The seed should be planted deeply enough to be in moist il, but no deeper. Shallow planting is preferable to deep planting, if condions permit. The thickness of planting will depend upon the size of the ariety, the moisture available, and the fertility of the soil. If checked, probbly 3½ feet apart each way with two or three grains per hill will be right for rdinary Idaho conditions, or the equivalent if not checked.

Cultivation.—If the soil is in proper condition at planting time, the subsequent are of the crop is ordinarily a simple matter. If the soil is kept in good lth and free from weeds, the farmer has done all he can do in the way of ultivation. A weeder or light harrow may be used just as the corn begins to ppear and once or twice more before it becomes too large. This is very nportant in securing the two conditions mentioned above. The cultivator ay then be used several times, care being taken not to cultivate so deeply s to injure the small roots so essential to the growth of the plant. Cultivation hould not cease because a certain time of the year has come or because the orn has reached a certain height. Shallow cultivation to keep a loose soil ulch for the retention of moisture may often be profitably practiced after he stage when cultivation usually ceases. Indeed, the later treatment of the rop often determines the profitableness of corn growing. Even where irrigaion is practiced it is better to use less water and to practice better methods of ultivation.

Harvesting.—For the silo, corn should be cut when it has passed the roasting ear stage and is entering the glazed stage. For [redacted] near the maturity stage as it can be handled corn for storage in the crib should not begin until the ear is thoroughly matured. This is particularly important in those parts of the State where the fall and winter months are very wet.

CULTURE OF PEANUTS FOR FORAGE.[a]

The peanut is a valuable leguminous plant for the South.[b] According to the Twelfth Census, the area devoted to peanut culture increased from 203,946 acres in 1889 to 516,658 acres in 1899, or an increase of 153.3 per cent, while the total production increased 233.5 per cent during the same period. These data show how the crop has grown in popularity, and has kept abreast with the greater market demands for the nuts. The market supplies are furnished mainly by the South Atlantic States, together with Alabama and Tennessee. The extension of peanut culture for market purposes can not be especially advised, but in many localities the crop can be grown to good advantage, and is deserving of more attention for forage and soil renovation. The Arkansas Experiment Station has grown peanuts for a series of years, and in a recent bulletin has given a summary of its observations on the culture and uses of the plant for stock food, together with recommendations for growing the crop more extensively for this purpose in Arkansas.

Attention was mainly given to the Spanish peanut, a small but prolific variety, well adapted to a wide range of well-drained soils, and succeeding well in the sandy pine flats, the rich alluvial river bottoms, the prairie regions, and the mountain sections of this State. This variety has been observed to make a good growth and give profitable returns wherever the cowpea can be grown with success. On some of the worn and infertile sandy lands of the State it has produced greater yields of grain and forage than corn, and has proved a more reliable crop.

A light or gray sandy soil is recommended for all varieties, but dark or clay soils containing sufficient lime, and soils treated with barnyard manure or green manures are considered suitable when the crop is grown for forage or for grazing. It is suggested that the soil be prepared as for corn, but with the surface in a finer and mellower condition. At the station the seed has been planted on the level ground and covered not more than 1 inch deep if moisture conditions were favorable, or about 2 inches deep when planted late in dry weather. The seed is generally shelled before planting, but the Spanish variety is sometimes planted without shelling, or by simply breaking the pod in two parts. In one experiment the station obtained 84.4 per cent of a stand from shelled nuts and 95.1 per cent from nuts only broken in two. In a germination test shelled nuts gave a germination of 98 per cent; pods broken in two, of 91 per cent; and whole pods, of 78 per cent. Whole pods were very slow in sprouting, while broken pods grew quicker, but did not germinate so promptly as shelled nuts. The work of shelling the nuts requires considerable time, but it was found that the Spanish variety can be quite successfully shelled with a cowpea huller, the loss in split seeds amounting to about 20 per cent, being more than compensated for in the time gained. Means for readily separating the broken from the whole seed makes the operation cheaper and more satisfactory. It is advised not to plant before warm weather has set in and is likely to continue; but planting may be done much later, and especially in the southern part of the State, where Spanish peanuts will mature good crops even if planted as late as August 1.

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[a] Compiled from Arkansas Sta. Bul. 84.

[b] Consult U. S. Dept. Agr., Farmers' Bul. 25, for general discussion of culture and uses of peanuts.

While Virginia and Tennessee varieties are usually planted at distances of from 12 to 18 inches in the drill, the Spanish peanut has been found to give heavier yields from closer planting. The results of experiments made by the station show that Spanish peanuts should be planted in rows 2½ feet apart, with the seed from 4 to 12 inches apart in the row.

The methods of culture usually practiced with corn, cotton, cowpeas, and potatoes are also recommended for peanuts. Shallow cultivation should be given frequently, and if the soil is in good physical condition it need not at any time be stirred deeper than 2 inches. The later cultivation should always be shallow. Covering the blossoms with soil is injurious, and experiments in determining the effects of covering the vines when in blossom resulted in a marked decrease in yield, due to the practice.

Peanuts grown for market purposes require more care in harvesting than a crop grown for stock food. As for all crops requiring curing, dry, sunshiny weather is best adapted to this part of the work. In order to prevent loss by sprouting of the ripe nuts, harvesting should be done soon after the first formed pods have matured. The plants are generally loosened in the soil by means of a plow running sufficiently deep and constructed to cut the tap root without tearing the nuts from the vines. When the plow has been run along the rows in the forenoon, the vines are usually gathered in the afternoon of the same day, three or four rows being thrown together. They are then either placed in small cocks or allowed to remain in the windrow, and when partly wilted are stacked about poles and left to cure from two to four weeks until ready for picking. "The plan usually followed at the station has been to allow the vines to remain several days in cocks or windrows. At intervals of two days these cocks or windrows are turned over, exposing the undersurface to the drying effects of the sun. When the vines have become thoroughly cured, they are hauled to the barn and spread in as thin layers as the barn space will allow and turned occasionally until thoroughly cured." The highest yield of nuts, 143.5 bushels per acre, was secured by the station from the Spanish variety grown on a rich garden soil, while on ordinarily fertile soil of calcareous and siliceous formation, which is well adapted to the crop, the Virginia white variety yielded 113.6 and the Spanish 109.09 bushels per acre.

The numerous estimates made by the station as regards the yield of hay from a crop of peanuts varies from 1 to very near 3 tons per acre. This hay is usually worth at least $10 per ton, and may be considered a by-product when the nuts are harvested for market. When the Spanish variety is grown for the purpose of being grazed by hogs, the hay may be mown before the hogs are turned into the field, or it may be grazed by cattle, horses, sheep, or goats and the hogs then given access to the nuts. * * * Spanish peanuts intended for grazing by hogs may be planted at any time after danger of frost is over on to the first or middle of July in north Arkansas, and as late as the middle of August in the southern part of the State. The time and methods of planting this variety of peanuts for hog feed are quite adjustable, and the crop may be associated with almost any system of cropping practiced in the South. The most profitable practices with this variety consist in growing the peanuts with some other crop, as corn, or after some crop has been harvested. When grains, Irish potatoes, crimson clover, and such crops that are harvested in May and June have been taken off, the same fields may be seeded to peanuts. They may be planted in missing places in the cotton and corn fields between the hills of corn in the rows, or in the middle, as is frequently the custom with cowpeas.

WINTERKILLING OF FRUIT TREES.[a]

About once in each decade, and sometimes oftener, a severe winter occurs in which an unusually large number of fruit trees are killed. An examination of the orchards after such winters shows many irregularities as to the extent of the injuries in orchards differently located and managed. Some varieties of fruits are uniformly less hardy than others, and the winter injury to these sorts may be traced directly to their greater tenderness. On the other hand, trees normally perfectly hardy in a locality may suffer serious injury or be entirely killed during such "test" winters, while other trees of the same varieties in the same orchard may escape injury entirely. During the prolonged cold winter of 1903–4 great losses were suffered by orchardists in the Lake Erie peach belt. Some orchards were entirely destroyed; others were apparently uninjured and came through the winter in a vigorous, hardy condition; and still others, while suffering severely, yet contained sections, rows or parts of rows, or individual trees that came through the winter uninjured.

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[a] Compiled from Ohio Sta. Bul. 157.

Many theories were advanced by the orchardists as to the cause of these anomalies, and as many contradictions appeared. The theory of insufficient drainage, which might be advanced as the cause of the injury in one orchard, would receive direct refutation in the next. If an orchard on elevated ground escaped in one instance it might be partially or entirely killed in another. In order to learn the cause of these irregularities, the horticulturist of the Ohio Experiment Station and his assistants visited both injured and uninjured orchards in Catawba Island and the peninsula of eastern Ottawa County, in Ohio, and made a thorough study of the matter, reporting the results of their investigations in a recent bulletin of the station.

Their investigations show that while a general or direct cause of the injury was, of course, the severe and long-continued cold the specific causes of the varying degrees of injury were exceedingly numerous. Generally speaking, it was found that where the vitality of the tree or orchard had been lowered by any cause whatever during its previous history the chances of injury to the tree by the cold were by so much increased. Factors observed in different orchards which contributed to low vitality in the trees were an insufficient degree of fertility, a low physical condition of the soils, prevalence of San José scale, leaf curl, peach-tree borers, extremely dry condition of the ground in some sandy and gravelly ridges, " water-logged" soils, etc.

Injury on bare ground.—There was a marked contrast in the extent of the winter injury on bare soils—soils given clean cultivation—and on covered soils. The bare soils froze deeper and the injury was much greater than on soils covered with a mulch or other material. The greater depth to which bare soils freeze in winter than covered soils was brought out in an experiment made at the station. A plat of peaches in an exposed situation was selected and a strip of sod 10 to 12 feet wide removed from one row, leaving the bare surface of the soil fully exposed to the cold. Another row alongside was left in grass which had been clipped and allowed to lie upon the ground.[a] Where the sod was removed the ground froze to a depth of 18 inches, while under the thin sod covering of grass and weeds in the other row the ground froze to a depth of about 8 inches. The trees in the bare ground " were very slow in starting into growth the following spring of 1904. All of the trees in this row were seriously injured by the cold, many large branches dying, while in one case the entire tree was so badly injured that but few leaves appeared throughout the season, and these upon shoots so feeble and slender that the tree might well be considered dead. Later in the season, however, some of the trees rallied slightly, though all showed a serious lack of vitality. The trees in the sod * * * did not suffer in the least degree—all making a healthy, uniform growth during the season of 1904."

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[a] See U. S. Dept. Agr., Farmers' [illegible]

Value of cover crops.—The value of an annual cover crop as compared with clean cultivation was found in an orchard eighteen years planted, one-half of which had been cultivated during the first half of each season and then sown to crimson clover, while the other half was given clean cultivation during the growing season. "Upon the clean culture area there was a much greater percentage of injury from the cold of the winter than upon the crimson-clover section. Where the clover crops had been grown and plowed down the trees showed remarkably healthy, heavy, dark-green foliage, contrasting sharply with the yellowish, sickly foliage of the clean-culture plat." Another grower in the injured-peach region stated that "not a single orchard or section of an orchard of which he knew, that had received even a light dressing of barnyard manure within the last year or two, had suffered noticeably from cold."

Injury in scale-infested orchards.—A 13-year-old orchard of 660 trees was found located on shallow limestone soil covered with a dense, heavy growth of bluegrass. The San José scale had wrought havoc in the neighborhood, but it had been kept under control in this orchard by spraying. As a result, not a tree in the whole block was killed by cold. Across the road from this orchard was another, located on similar soil and also in sod, but in which the scale had not been controlled. "The story is told in two words—entirely dead."

Injury from leaf curl.—Another instance is cited in which an orchard was sprayed in the spring of 1902 for the control of the scale, with the exception of three rows through the middle, which were overlooked. As a result, the scale increased rapidly during this season on these unsprayed trees, and they were also attacked by leaf curl, which practically defoliated them. The whole orchard was sprayed in 1903, nevertheless the trees had been so weakened by the leaf curl of the preceding year that the good care given them in 1903 was unavailing, and every tree in the three rows was killed, while every tree on either side of them which had been sprayed came through the winter sound, vigorous, and healthy.

Benefits from banking trees.—A simple, easy, and very effective method of preventing winterkilling of peach trees was observed in the orchard of one grower. Just before winter set in this grower hauled manure to the orchard, but instead of scattering it beneath the trees in the usual way he banked a very few forkfuls immediately around the stem of the tree. When the supply of manure ran out peat or earth was hauled into the orchard and banked around the stem of the tree in the same manner. "The results from the use of these materials were uniform, and, surprising as it may seem, every tree that received this simple treatment survived the winter without the least injury from cold, while the few trees and sections of rows left here and there unbanked and serving as 'checks' in the experiment died almost to a tree." Another orchard of some 500 trees a little farther to the west of this orchard, "which had received the same high culture and good care, with the exception of the simple banking process, was almost a total loss." The trees in these orchards were extremely vigorous and had made a rank growth, which made them peculiarly susceptible to injury by freezing.[a]

Orchards in sod.—On the same farm trees on a piece of ground which was so stony that it could not be cultivated and which was kept in bluegrass sod, with a heavy mulch of coarse material, such as cornstalks, barnyard manure, etc., about the stems, according to the true "sod-and-mulch" method, came through the winter without injury.

These investigations bring out strikingly the necessity of such continuous and thorough cultural practices in the orchard as shall maintain the trees at all times in a vigorous, healthy condition. The fertility and vegetable matter of the soil must be maintained by the addition of manure or the growing of cover crops. Spraying to control insect pests and fungus diseases must be thorough and unremittent. Trees on undrained or very rich soil, trees weakened by overbearing or by borers, all alike invite winter injury. Cover crops and mulches protect the ground from deep freezing and resultant winter injury. Sod serves the same purpose. Banking up the trunks with a few shovelfuls of manure or earth appears to have a marked favorable influence.

CRANBERRY CULTURE.[b]

As a recent Farmers' Bulletin[c] by L. C. Corbett, of this Department, shows, cranberry raising has from a very small beginning grown to be an industry of the first magnitude and receives more or less attention in 19 States. According to the census of 1900 the total area in cranberries was 20,364 acres, yielding a product of 977,516 bushels; Massachusetts standing first with 598,906, New Jersey second with 230,221 bushels, and Wisconsin third with 111,098 bushels.

Several of the experiment stations have given more or less attention to the subject. The Massachusetts and New Jersey stations have made thorough studies of insect enemies and fungus diseases of cranberries and the management of bogs to control or repress injuries from these sources, and the West Virginia Station has reported successful attempts, under the direction of L. C. Corbett, to grow cranberries in the mountain swamps of that State.

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[a] For relation of cultivation to winterkilling see U. S. Dept. Agr., Farmers' Bul. 202, p. 12.

[b] Compiled from Wisconsin Sta. Bul. 119; West Virginia Sta. Bul. 86.

[c] U. S. Dept. Agr., Farmers' Bul. 176. For information regarding cranberry insects and diseases see Farmers' Buls. 178 and 221.

The Wisconsin Station has been carrying on investigations with cranberries during the past two years in cooperation with the Office of Experiment Stations of this Department. A recent bulletin of that station presents a detailed account of this work, which contains matter of general interest.

Frost protection.—Untimely frosts, which occur practically every month of the growing season in Wisconsin, often seriously injure the crop. On the night of August 8, 1904, frost ruined about 60 per cent of the fruit in Wisconsin, causing a loss of approximately $200,000. A number of local factors have been observed which have an important bearing on frost prevention. It has been noticed that frost often does not occur uniformly over a broad, level moorland, but forms in patches. These frost patches occur where the marsh is poorly drained or covered with weeds, grass, and moss, while clean, well-drained, or sanded land often escapes. It appears that the solar heat absorbed and radiated by a clean, sanded bog is considerably greater than by a bog covered over with a mat of grass. During the months of July and August there was a variation in the minimum temperature of as much as 13° in favor of the bare, sanded bog. On the bog covered with clean vines also the minimum temperature was uniformly a little higher than on a bog covered with a sort of blanket of dead grass and growing vegetation.

> The data given in comparison of the temperatures over bare, sanded bog, and bog covered with grass and growing vegetation, showing a difference in temperature in favor of the sanded bog, can not be considered to mean that the covering in the one case was the sole cause of difference.
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> The low specific heat of sand and the consequent high heating of it during days of sunshine, and also the lack of evaporation over its surface because of the lack of capillarity in bringing water to the surface, render it especially valuable as a conserver of heat. It will thus be seen that sanding and freedom from weeds, grasses, or any form of useless vegetation over the bog are two very important factors in protection from frost.
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> There is a third condition, and one wholly within the control of all cranberry growers, which is perhaps of greater importance than all the others together as a means of frost protection—that is, drainage. The effect of thorough drainage by the use of deep and close ditches in aiding in protection from frost can hardly be overvalued. The State Experiment Station has gone through the past summer, in which there were several frosts and one or two very hard frosts, without any loss from freezing whatever, notwithstanding the fact that certain parts of the bog were not flooded once during the season. On other adjoining marshes flooding was resorted to many times during the summer for protection, and yet a loss of about 60 per cent of the total crop

was sustained on the morning of August 8. While this protection at the station was not due to good drainage alone, there is no doubt that it had much to do with warding off the frost. And the three conditions above mentioned—that is, good drainage, sanding, and freedom from excessive vegetation—are the only conditions which could account for this extra protection to the station. * * *

The sole means used heretofore throughout the State of Wisconsin for protection against frost has been that of flooding the marshes with water. This method, where the system for handling the water is so arranged that it may be done rapidly, and where the temperature of the water is sufficiently high, is a very efficient method, and will doubtless always remain the surest protection against severe frosts, but it may often be used, and undountedly is ofttimes used to the very serious damage of the crop. This, of course, means a thorough flooding of the marsh or a flooding where it is necessary to put the berries under water. However, such heavy flooding is only necessary during the latter part of the season, when we are subject to hard frosts, and this method of protection may be well and safely used for the occasional and untimely frosts of summer. At such times it is seldom necessary to raise the water over the surface, especially if the flooding ditches are close together, for the high temperature of the water at this season and its high specific heat may make a small amount ample for light frost protection. * * *

The size and depth of the ditches used in conveying the water from the reservoirs and spreading it over the planting are of great importance, especially on nights of quick, heavy frosts, when it is necessary to flood as rapidly as possible. There should be one or more large main ditches extending from the reservoir through the planting, coming in contact with each section, so that each may be flooded independently. * * *

If the greatest efficiency would be had in flooding, the canal should be so constructed that the full head of pressure in the reservoir may be carried to the end of the flooding canal. In this case the canal might be kept filled during the season of probable frost, the only extra loss of water being that which would come from the extra surface presented for evaporation and the seepage through the side dam, an amount of little consequence in large systems. In at least three instances in Wisconsin this year crops were damaged to the extent of many thousand dollars because of the insufficient capacity of the flooding canals. In each case the expenditure of a few hundred dollars would have constructed good substantial canals of ample capacity for flooding at all times.

Sanding and weeding bogs.—Relative to sanding at the Wisconsin Station, "observations on newly planted marsh, both sanded and unsanded, would go to show that the unsanded bog promoted a more rapid and vigorous growth of vines, at the same time promoting a more rapid and vigorous growth of weeds. While there is no doubt as to the great value of sanding, the question of the time of sanding must be decided by each marsh owner for himself, it being a question between the extra expense of weeding on the one hand and the apparent slower growth of vines on the other."

After a bog has been prepared and planted many growers leave it without much further attention, as a result of which it is soon overrun with grass. By thorough weeding and good drainage the vines at the experiment station produced at the average rate of 62.5 barrels per acre, while the average yield per acre for the State during the same year was less than 5 barrels, a result which is decidedly in favor of the well-prepared and well-cared-for marsh.

Liming.—Experiments at the Wisconsin Station were made on the liming of cranberries, both quicklime and marl being used. The applications were made in June. At the end of the season no effect of the lime could be observed on the growth of the young plants. Liming the American Belle variety at the Rhode Island Station, however, proved positively injurious.

Harvesting.—The effect of time of harvesting on yield was also investigated at the Wisconsin Station. Harvesting in Wisconsin usually begins the forepart of September, no matter what the condition of the crop. In the test, berries were picked on September 8, 24, and October 8. "The growth during the 30 days showed an increase in size of 19 per cent, 10 to 11 per cent being realized during the first 16 days and the rest of the growth between September 24 and October 8. It will thus be seen that almost 19 per cent clear profit on a crop would have been realized could the picking have been deferred 30 days."

Grading cranberries.—After harvesting, cranberries are graded according to size and quality. The Wisconsin Station describes a very successful apparatus for this purpose. The berries are first poured in the hopper of the machine, from which they pass through a fan blower, which takes out the chaff, etc. They then fall into several bottomless V-shaped troughs. The opening in the bottoms of the troughs gradually widens with the length of the troughs. The berries fall through the troughs at different places, according to size, into separate compartments. From these compartments each grade of berries is carried over a series of "jumpers," which grades them according to firmness and quality. These "jumpers" consist of a series of steps.

> The surface of the steps is made of glass or highly polished hard wood, and the good berry striking upon this hard polished surface rebounds and, if the force is sufficient to raise it over the curtain hung in front of and a little above the surface of the step, it falls over the outside of the curtain and passes down into the box with the good berries. A series of these steps are so arranged one below another that the berry has several chances of jumping over the curtains and may get several bruises before it finally reaches the box with the good berries. The poor, soft, and bruised berries, being unable to rebound because of a lack of elasticity, slide from one step to another, finally reaching the bottom and sliding out under the curtain into the slush box. If any such rough methods of handling were used on the apple or any other fruit, the keeping quality would be entirely destroyed, and it is only the very high keeping quality of the cranberry that brings it through this method of handling and still makes it the best keeping fruit that we have.

That this process of jumping does injure the keeping quality of the berries is shown by the fact that the berries "used for study at the station always show the first signs of decay on those spots bruised in going over the jumpers."

Storage.—Relative to storage, the Wisconsin investigations show that berries stored in a wet condition do not keep well. A sudden change in temperature from a cold to a warm, moist atmosphere is also injurious to the keeping quality, due to a deposit of moisture on the berries, which not only affects their physical condition, but permits of the rapid growth of disease-producing fungi and bacteria on the fruit. In the season of 1903, berries picked early in the season kept better than those picked later. The poorer keeping quality of the late-picked berries in this instance is thought to be due to the wetness of the fall and the consequent greater exposure of the late-picked samples to moisture and cold nights rather than to the extra ripeness of the berries. In 1904, the late-picked berries kept decidedly the best, and this result seems to be in accord with that of cranberry growers generally.

LIME-SULPHUR-SALT WASH.[a]

This insecticide in one or another form has for years been relied upon by the fruit raisers of the Pacific coast States in combating San José scale and other scale insects. The experience of western fruit growers with the remedy has been very satisfactory. On account of the demonstrated efficiency of the lime-sulphur-salt wash in California, Oregon, and Washington preliminary tests were made in the East by the Bureau of Entomology and by other investigators to determine its value under eastern conditions. The first results obtained from these experiments were not satisfactory, but later experiments have yielded such gratifying results that the remedy is now widely used and recommended by the Bureau of Entomology and various experiment stations, particularly in Illinois, New York, Ohio, Connecticut, New Jersey, and Maryland. The chief advantages which this wash seems to possess are that it is highly effective in the destruction of the San José scale, other scale insects, plant lice, and other similar pests. It also controls to a large extent the development of certain fungus diseases, such as peach-leaf curl. The remedy may be applied during the dormant period of fruit trees, and therefore with comparative safety to the trees. It may be made at home of materials of known purity and is comparatively inexpensive.

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[a] Compiled from Connecticut State Sta. Bul. 146; Illinois Sta. Circ. 85; Maryland Sta. Bul. 99; New Jersey Stas. Bul. 162; New York State Sta. Buls. 182, 228, 247, 254; Ohio Sta. Bul. 144; U. S. Dept. Agr., Farmers' Bul. 127; U. S. Dept. Agr., Bureau of Entomology Bul. 46; North Carolina Dept. Agr., Ent. Circ. 13.

A great many variations have been made in the formula of this wash for the purpose of determining, so far as possible, which are the effective insecticide elements in the wash and in what proportion the combination is most effective. In experiments of this sort at the Connecticut State Station in 1904, 15 formulas were tested containing lime and sulphur in one form or another. The proportions varied considerably, but in general it was found that a boiled mixture of lime and sulphur containing as much or a little more lime than sulphur was as cheap and effective as any other mixture for commercial orchard work. Some difference of opinion exists regarding the advisability of adding salt to the mixture. Some investigators find the lime and sulphur mixture without the salt as effective as when the salt is added, and therefore omit the salt as a matter of convenience and economy. One of the formulas used at the Connecticut State Station included 14 pounds each of lime and sulphur per 40 gallons of water; another contained 20 pounds of lime for the same amounts of the other ingredients. In Maryland a formula is recommended containing 20 pounds lime, 15 pounds sulphur, 10 pounds common salt, and 50 gallons water. In Illinois the formula recommended by the experiment station contains 15 pounds each of lime, sulphur, and salt per 50 gallons of water. The Ohio Experiment Station recommends 50 pounds each of lime, salt, and sulphur per 150 gallons of water. The formula recommended by the North Carolina department of agriculture contains 20 pounds lime, 17 pounds sulphur, and 10 pounds salt per 50 gallons of water.

In the Eastern States this wash was first used essentially in the form originally recommended by California fruit growers—after thorough boiling. Numerous experiments have been made since that time to determine the proper length of the boiling period, in order to secure the best results. According to recent experiments in Connecticut, New York, Georgia, and elsewhere, it is not necessary to boil this wash for two hours, as has sometimes been recommended, but equally satisfactory results may be obtained by boiling from thirty minutes to one hour. Considerable saving is thus effected in fue and time. The North Carolina department of agriculture recommends that the mixture be boiled for one-half hour after the lime i thoroughly slaked. Where it is desirable to avoid the inconvenienc of boiling by the application of artificial heat, it has been foun possible to prepare self-boiling mixtures containing lime, sulphu and caustic soda. One of the most frequently recommended fo mulas for this mixture contains 10 pounds lime, 8 pounds sulphu and 4 pounds caustic soda per 25 gallons of water. In prepari mixture the lime is first slaked in hot water, after which the hur is added, and later the caustic soda. Water is then added n time to time to prevent the mixture from boiling over and to ntain a liquid consistency. As soon as boiling caused by the nical action ceases, the amount of water necessary to make the iired volume may be added. In the preparation of the fire or m boiled lime-sulphur-salt wash, it is usually recommended that 5 gallons of water be brought to the boiling point, after which hur is mixed with hot water to form a paste and added to the ing water. The lime is then added and water is poured in from to time to prevent the mixture from boiling over. The mix- is stirred until the process of slaking is completed, after which salt is added. It should then be boiled, as already indicated, for half hour or longer.

he lime-sulphur-salt wash was first applied in the Eastern States winter or early spring remedy, care being taken to finish the ying before the buds began to swell. Recently numerous experi- ts have been tried, particularly in New York and Ohio, in test- the value of the remedy as a fall application. The results of e experiments in New York indicate that the injury from the lication of the lime-sulphur wash in the fall was very slight in case of peaches, plums, and cherries. In some cases the injury hardly noticeable. As a fall application the lime-sulphur wash, -sulphur-salt wash, and lime-sulphur-caustic soda wash were it equally effective. In Ohio the application of the insecticide e fall was not detrimental to peaches or plums, and the destruc- of the San José scale was as complete as when the remedy was lied in the spring.

a result of the tests thus far made at the various agricultural riment stations, numerous orchardists have applied the lime- hur-salt wash to different kinds of fruit trees on a commercial . In Connecticut, during the spring of 1904, about 100,000 were sprayed with lime-sulphur mixtures with generally satis- ry results. In the Southern States, according to the North Caro- department of agriculture, " the lime-sulphur-salt wash bids fair ecome popular as a winter spray for orchards, not only as a dy for the San José scale, when that pest is present, but also on unt of its general effect on the tree in removing dead bark, oying hibernating spores of fungus diseases, checking scurfy , oyster-shell scale, and to a certain extent other insect pests." ng the winter of 1904 the lime-sulphur-salt wash was applied in h Carolina to about 75,000 trees and with excellent results. The ois Experiment Station, one of the first to recommend the use of sulphur-salt wash under eastern conditions, refers to the problem of eradicating San Jose scale by means of lime-sulphur washes, as follows:

> The very extensive practical and experimental work of this office for the destruction of the San José scale, carried on during the past four years, has now demonstrated the possibility of keeping this insect in check by an occasional treatment, and indeed of almost completely clearing an infested orchard under fairly favorable conditions, by one or two sprayings of the trees with one of the lime and sulphur washes. The materials for these washes are not costly, are easily obtained anywhere, are prepared for use by simply boiling them together. and are applied with an ordinary spray pump, such as is commonly used in orchard work.

DESTROYING PRAIRIE DOGS.[a]

The prairie dog is well known to the inhabitants of the western plains. A full description of the animal, its habits, and methods of exterminating it is given by Dr. C. Hart Merriam in the Yearbook of this Department for 1901, page 257. Largely owing to the indifference of nonresident landowners and the destruction of the prairie dogs' natural enemies they have increased so rapidly and are now doing so much damage that an act was passed by the Nebraska legislature for 1903 declaring them to be a nuisance and requiring landowners to take measures for exterminating them. During the same year the Kansas legislature made provision for continuing experiments in the preparation and use of poisons for combating prairie dogs and other injurious rodents. According to Doctor Merriam the number of prairie-dog holes per acre varies from a few up to more than 100 and averages about 25. Near Alma, Nebr., the number of holes ranged from 35 to 64 per acre and at Carlsbad, N. Mex., the number was 50. Prairie dogs cause far more damage than is generally realized. They not only feed upon the native grasses of the range country, in this way destroying so much grass that the carrying capacity of the range is reduced to about 50 per cent of what it otherwise would be, but in the cultivated fields they have also proved very destructive to various crops, including alfalfa, cereals, potatoes, sugar beets, etc.

The treatment which has heretofore proven most effective is the use of strychnin and potassium cyanid. There are, however, many objections to the free use of such deadly poisons as these, and so different methods of fumigation, especially with carbon bisulphid, have been tried.

The use of carbon bisulphid has been found effective, especially with small colonies, but is very laborious and expensive. The Nebraska Station, therefore, attempted to find a cheaper substitute for carbon bisulphid. It was found that "light hydrocarbon by-products of Pintsch gas, which cost 7 cents per gallon, will take the place of bisulphid of carbon, which costs the farmers about $1.10 per gallon." "This substance is a by-product formed in the condensation of Pintsch gas. When the gas is compressed to fill the storage cylinder of the railroad coaches, one-tenth of the entire quantity liquefies. This liquid is useless for illuminating purposes. As it is a constant product of the Pintsch gas factories, we may assume that it will be abundant as long as these factories operate. * * * Its vapors are heavy and readily penetrate into the recesses of the holes. It does not seem to be absorbed as readily by the soil as carbon bisulphid."

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[a] Compiled from Kansas Sta. Bul. 116; Rpt. 1903–4, p. XVII, Nebraska Sta. Bul. 86.

The following instructions are given regarding fumigation:

> Let one man proceed in advance with a spade and cover up all apparently deserted holes with a sod. He is to be followed by another man who inserts into each remaining hole a cow or horse chip saturated with the hydrocarbon. The third man closes all the treated holes. Working in this way, three, with a boy to run errands, can cover 20 acres of an average dog town per day. After going over the field the first time it is comparatively easy for the owner to drive over it each day carrying a sack of chips, a jug of hydrocarbon, and a spade in his buggy. He can then treat any missed or opened holes in a comparatively short time.
>
> For very large tracts covered by prairie dogs it is probable that a combination of poison and fumigation will prove most economical. Poisoning should be done during the time of year when food is scarce. After distributing the poison once or twice some time should be allowed to elapse. At the end of this time, when unoccupied holes can be readily distinguished from those occupied by dogs, the remaining dogs can be killed by fumigation. About the only advantage in using poison at all is the saving of labor. It seems to be necessary to resort to fumigation in the end to entirely exterminate a colony.

Strychnin seems to have proven the most effective poison. A formula for preparing this poison is given as follows in a bulletin of the Kansas Station:

> Dissolve 1½ ounces of strychnia sulphate in a quart of hot water. Add a quart of sirup—molasses, sorghum, or thick sugar and water—and a teaspoonful of oil of anise. Thoroughly heat and mix the liquid. While hot pour it over a bushel of clean wheat and mix completely. Then stir in 2 or more pounds of fine corn meal. The quantity of corn meal will depend upon the amount of extra moisture present. There should be enough to wet every grain of the wheat and no more. Care should be taken that there is no leakage from the vessel in which the wheat is mixed. Let the poisoned grain stand overnight, and distribute it in the early morning of a bright day. Use a tablespoonful of the wheat to each hole occupied by prairie dogs, putting it near the mouth of the burrow in two to three little bunches. Do not put out the poison in very cold or stormy weather. It will keep for a considerable time, and is much more effective after a cold period, as the animals are then hungry and eat the grain readily. A bushel of wheat should poison 1,000 to 1,200 holes. An excellent substitute for the oil of anise in the above formula can be made by soaking 2

ounces of green coffee berries in the whites of three eggs. Let this stand for about twelve hours and use the liquid instead of anise oil.

Doctor Merriam says "poisons are of very little use except in winter and early spring, when the ordinary food of the prairie dog is scarce and difficult to obtain."

The effectiveness of the systematic crusade against the prairie dog is sufficiently apparent from the fact that in Kansas it is estimated that in 1904 the prairie dogs were destroyed over an area of 700,000 acres at an expenditure of about $1,000. During the three years in which this work has been carried on nearly three-fifths of the whole infested area of Kansas has been reclaimed from the prairie dogs at a total expense of $3,000. The Kansas law on this subject requires the township trustees to supervise the field work of killing prairie dogs, and it is estimated that the work is thereby rendered more efficient.

It should be noted that the methods of poisoning and fumigation used in the destruction of prairie dogs are also effective against pocket gophers, field mice, ground squirrels, rabbits, and, to a less extent, rats and moles. Fumigation with the hydrocarbon by-products of Pintsch gas or with carbon bisulphid may be used for animals which live in open burrows, while the poison method may be used for pocket gophers and moles.

CLEAN MILK.[a]

The production of clean milk is of vital importance to infants and invalids and of no little concern to every consumer of this highly nutritious food. It is universally recognized that much of the sickness and many of the deaths of infants are due to impure milk, and it is also quite probable that some of the digestive disturbances of adults may have the same origin. Aside, however, from possible injurious effects, no one would willingly consume milk known to be impure.

It is the purpose of this note to call attention to the nature, extent, and means of prevention of some everyday forms of milk contamination rather than to discuss the transmission of diseases, such as tuberculosis or foot-and-mouth disease, from diseased cows to human beings by means of milk, or outbreaks of such diseases as typhoid fever or diphtheria, which have again and again been traced to the milk supply infected through the ignorance and slovenly habits of persons engaged in this business.

Milk may become contaminated at every stage from production to consumption. In the udder of the healthy cow it may acquire a disagreeable odor or taste from the food consumed by the animal or may contain bacteria. Whether or not the latter are invariably present in the normal udder is still a matter of considerable discussion. At any rate these minute forms of plant life spoken of indiscriminately as bacteria, germs, microbes, and micro-organisms are always present in milk as it is usually obtained and bring about in time many changes in the milk, of which souring, due to a decomposition of the milk sugar, with the resulting formation of lactic acid, is the most familiar.

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[a] Compiled from Connecticut Storrs Sta. Bul. 25; Illinois Sta. Buls. 91, 92; Michigan Sta. Bul. 221; Nebraska Sta. Bul. 87; New York Cornell Sta. Bul. 203; Pennsylvania Dept. Agr. Bul. 125.

Doubtless the greatest contamination of milk occurs at the time of milking. In the first few streams drawn are always large numbers of bacteria. Dust floating in the air settles in the open pail. The movements of the animal and the manipulations necessary in milking loosen the particles of filth on the udder and adjoining portions of the cow, and they are collected in the pail along with the milk. From the hands and clothing of the milker are added further impurities. When the yards or stables in which the milking is done are filthy, when the air is laden with dust, as is always the case when bedding is supplied or the animals fed just previous to milking, when the cows are covered with dirt from wading in muddy pastures or unclean yards or from lying in the gutter due to faulty construction of stables, and when milkers are slovenly in their habits, the quantity of filth that gets into milk is truly enormous.

In an experiment reported by W. J. Fraser, of the Illinois Station, some figures were obtained as to the amount of dirt falling from udders apparently clean, soiled, and muddy. A dish of the same diameter as an ordinary milk pail was held under an udder for 4½ minutes, while the milker went through motions similar to those made in milking, but not drawing any milk. The dirt thus collected was thoroughly dried and weighed. As an average of 75 trials made at different seasons of the year it was found that the weight in grams of dirt which fell from udders apparently clean was 0.0152, from udders slightly soiled 0.1316, and from muddy udders 0.8831. From these data it was calculated that from muddy udders 1 ounce of dirt would fall into the milk in 32 milkings, or that every 275 pounds of milk would contain 1 ounce of filth. After each of the above tests the udder was washed and the dirt collected as before. It was found that with udders apparently clean 3½ times as much dirt fell from the unwashed udders as from the same udders after they were washed. With soiled udders the ratio was 18, and with muddy udders it reached 90.

Conditions favoring the entrance of dirt into milk are also favorable to bacterial contamination. Data obtained at the Illinois Station on this point may be cited. Dishes having an area of about 10 square inches, and filled with a nutrient medium upon which bacteria grow, were uncovered for about one-half minute under various conditions. The average numbers of colonies which developed in the culture medium, and which corresponded presumably to the number of individual bacteria which fell into the dishes during the exposures, were as follows: Exposure made in open field, 0.9; barnyard, 13; well-kept barn during milking, 32; poorly kept barn during milking, 168; before feeding, 46; after feeding, 109; after brushing cows, 307; under apparently clean udders, 578; under washed udders, 192. This affords some indication as to the effect of some of the different operations commonly performed in dairying upon the bacterial content of the milk.

Similar data have also been reported by A. L. Haecker and C. W. Melick of the Nebraska Station. Petri dishes, as in the above experiments, were exposed under udders which had been (1) sponged with water, (2) sponged with 5 per cent carbolic-acid solution, (3) smeared with vaseline, and (4) merely brushed with the hand. The motions of milking were gone through with, although no milk was drawn. When the exposures were made in the stable the number of colonies which developed in the petri dishes exposed under udders treated with carbolic-acid solution was 344, under udders treated with vaseline 346, under udders treated with water 483, and under udders not treated 20,500. When the exposures were made in the pasture the corresponding numbers were 86, 92, 120, and 310. The value of sponging the udder with water before milking as a means of reducing bacterial contamination is apparent.

It would be an easy matter to multiply almost indefinitely observations on the amount of dirt getting into milk in the ordinary processes of milking and on the extent of bacterial contamination. As the two are more or less closely associated, the number of bacteria indicates to a certain extent the degree of cleanliness employed. This is of especial value in inspection, as the estimation of dirt in milk is somewhat difficult. The filth that gets into milk is to a large extent readily soluble in the milk, and no straining, filtering, or centrifuging can remove it. Following milking, however, the number of bacteria is constantly being increased from unclean and unsterile utensils and apparatus used in straining, cooling, and transporting the milk.

There are, of course, many other ways in which milk may become impure. Exclusive of deliberate adulteration, those mentioned are, however, the most obvious. The greatest amount of dirt comes from the exterior of the cow during milking. Some of the means of producing clean milk may be noted.

By using a covered milk pail, which has been described in a previous number of this series,[a] W. A. Stocking, jr., of the Connecticut Storrs Station, found that in a dairy where conditions of cleanliness were good 63 per cent of the dirt was excluded. When such dirt was once permitted to get into the milk, less than 47 per cent could be removed by prompt straining. Often the difference was very much greater than the 16 per cent here stated. The covered pail excluded 29 per cent of the total number of bacteria, while prompt straining removed only 11 per cent. The advantages of using a covered milk pail seem apparent from those figures alone.

W. J. Fraser, of the Illinois Station, summarizes some of the means of improving milk supplies as follows:

> Keep the cows clean, and do not compel or allow them to wade and live in filth. This means clean yards and clean, well-bedded stalls. Everything short of this is positively repulsive and should not be tolerated any longer in a civilized community.
>
> Stop the filthy practice known as "wetting the teats," by which is meant the drawing of a little milk into the hands with which to wet the teats before and during milking, leaving the excess of filthy milk to drop from the hands and teats into the pail.
>
> Wash all utensils clean by first using lukewarm water, afterwards washing in warm water, and rinsing in an abundance of boiling water, then exposing until the next using in direct sunlight, which is a good sterilizer.
>
> Use milk pails, cans, etc., for no other purpose but to hold milk.
>
> Keep out of these utensils all sour or tainted milk, even after they have been used for the day. Using them for this purpose at any time infects them so badly that no amount of washing is likely to clean them. Bacteria are invisible, and millions can find lodging place in the thin film of moisture that remains after dishes are apparently clean.
>
> Brush down the cobwebs and keep the barn free from accumulations of dust and trash.
>
> Whitewash the barn at least once a year.

C. E. Marshall and W. R. Wright, of the Michigan Station, give the following outline for milk management:

> (1) The cow should be sound—no disease should exist in the animal.
>
> (2) The feed should be good and free from aromatic substances. If these aromatic foods are used, they should be employed according to those methods which will not cause odors or flavors to appear in the milk.
>
> (3) The cow should be groomed and hair about the udder preferably clipped.
>
> (4) The udder should be moistened during milking.
>
> (5) The milker should be a neat, tidy person.
>
> (6) The milker should be free from disease and should not come in contact with any communicable disease.
>
> (7) The milker's hands and clothes should be clean while milking.
>
> (8) The pail should be sterilized.
>
> (9) The stall should be such as to reduce the amount of disturbance of dust and dirt.
>
> (10) There should be good light, good ventilation, and good drainage in the stable.

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[a] U. S. Dept. Agr., Farmers' Bul. 210, p. 26.

(11) The stable should always be kept clean.
(12) Feeding and bedding, unless moist, should be done after milking.
(13) A dustless milking room is desirable.
(14) Milk should not stand in the stable.
(15) If milk is aerated, it should be done before cooling and in pure air.
(16) The sooner the milk is cooled after milking the better.
(17) Keep the milk as cold as possible when once cooled.

O. F. Hunziker, of the New York Cornell Station, summarizes a bulletin on the care and handling of milk as follows:

> The greater the attention paid to scrupulous cleanliness in handling milk at all stages, the shorter the time that elapses between the drawing, straining, and cooling of milk, and the lower the temperature to which it is cooled, the greater its freedom from micro-organisms, the longer it will retain its normal condition, the more profitable its production will be, and the more wholesome will it be for old and young.

D. H. Bergey, of the University of Pennsylvania, says:

> The conditions in a dairy which appear to be necessary to produce a milk which is satisfactory in respect to its bacterial content may be stated as follows:
>
> (1) The selection of cows free from inflammatory disease of the udder.
>
> (2) Housing the cows in clean, well-ventilated stables, with nondust-producing bedding.
>
> (3) The systematic daily cleaning of the cows with currycomb and brush and the washing of the udder and flanks with clean warm water a short time before each milking.
>
> (4) The careful regulation of the diet and physical condition of the cows, so as to maintain their health.
>
> (5) The selection of efficient milkers and attendants who will faithfully carry out the minutest details of the regulations necessary to produce pure milk.
>
> (6) The provision of flowing water, soap, and towels, to permit the milkers to wash and scrub their hands after milking each cow.
>
> (7) The provision of freshly laundered cotton slips and caps, to be worn by the milker over his regular clothing.
>
> (8) The sterilization by means of steam of the various milking, straining, cooling, and bottling apparatus before each milking.
>
> (9) The rapid cooling and bottling of the milk, so as to remove it permanently from contact with air at the earliest possible moment. The milk should be cooled to about 40° F. before it is bottled.
>
> (10) The transportation and storage of milk in such a manner as to prevent its temperature rising much above the point to which it has been cooled during transportation, so that it may reach the consumer without undergoing any alteration.

CONSTRUCTION AND VENTILATION OF POULTRY HOUSES.[a]

As an incident to poultry investigations of various kinds which have been conducted by a number of experiment stations considerable attention has been given to the construction of poultry houses and the amount of space per fowl which will give best results as regards health and productive capacity. For example, in a series of experiments made at the Maine Station, which have been noted in a previous bulletin of this series,[a] it was shown that the best results were obtained by providing from 8 to 10 feet of floor space for each hen.

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[a] Compiled from Maine Sta. Bul. 100.

There is great difference of opinion as to the best method of calculating the number of fowls a poultry house will accommodate. The common method of calculation is based upon floor space, the height being considered immaterial. Houses built on this principle are low, and consequently the least expensive that can be constructed. Another method of calculation is based upon the amount of perch room, while a third is based upon the volume or cubic contents. Various poultrymen recommend 6, 8, and 10 cubic feet of space per fowl.

In view of the widely divergent views on this subject and the lack of definite knowledge K. J. J. Mackenzie and C. S. Orwin,[b] of the Southeastern Agricultural College of England, undertook a series of experiments to more definitely determine the amount of air space required by poultry. They studied the frequency and rate of respiration in fowls, the amount of carbon dioxid thrown off, the amount of vitiation of the air which the fowls could stand without injury, and examined different types of poultry houses with reference to their suitability for furnishing proper conditions of ventilation. Assuming that the air of poultry houses should not contain more than 9 parts of carbon dioxid per 10,000 of air they estimated that each fowl must be supplied with about 40 cubic feet of air per hour, the requirements of small fowls being practically the same as of large.

In wooden poultry houses with ventilation at the top the air apparently changes about four times per hour. Each bird must therefore have 10 or more cubic feet allotted to it.

The number of birds a house will hold depends on its volume and not on the floor space or perch room. The maximum number is found by dividing the volume expressed as cubic feet by ten. We prefer to keep within this number.

The greatest capacity can be most economically obtained from a given amount of timber if the house is cubical in shape. This can not be quite realized in practice owing to the necessity for a sloping roof, but the nearer one gets to it the better.

Low houses, besides being uneconomical, tend to induce overcrowding.

Overcrowding causes diminished egg production and encourages roup, tuberculosis, and other diseases.

The atmosphere in a long, low house with the bottom out is about twice as good as one with the bottom in. The air changes about twice as quickly, and it would appear this must be accompanied by a draft.

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[a] U. S. Dept. Agr., Farmers' Bul. 114, p. 18.

[b] Jour. Southeast. Agr. Col., Wye, 1904, No. 13, p. 84.

Excellent results, both as regards ventilation and warmth, ha been secured at the Maine Station by the use of the curtained fro poultry house with curtained roosting closets shown in figures 1 and This building is 14 feet wide and 150 feet long.

The back wall is 5½ feet high from floor to top of plate inside, and the fro wall is 6⅔ feet high. The roof is of unequal span, the ridge being 4 feet i from the front wall. The height of the ridge above the floor is 9 feet. Th sills are 4 by 6 inches in size and rest on a rough stone wall laid on the surfa of the ground. A central sill gives support to the floor, which at times is qui heavily loaded with sand. The floor timbers are 2 by 8 inches in size and a placed 2 feet apart. The floor is two thicknesses of hemlock boards. All the rest of the frame is of 2 by 4 inch stuff. The building is boarded, paper and shingled on roof and walls. The rear wall and 4 feet of the lower part the rear roof are ceiled on the inside of the studding and plates and pack

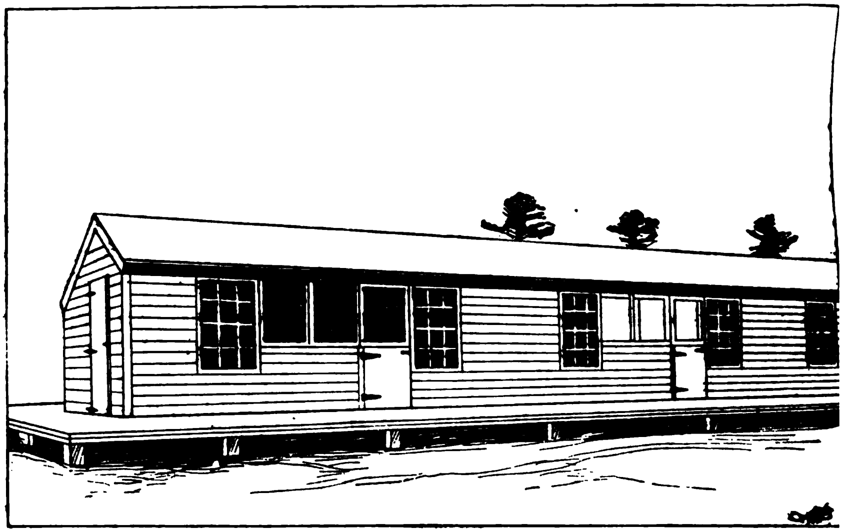

FIG. 1.—Two sections of curtain-front poultry house.

very hard with dry sawdust. In order to make the sawdust packing continuo between the wall and roof, the wall ceiling is carried up to within 6 inches o the plate, then follows up inclining pieces of studding to the rafters.

The short pieces of studding are nailed to the studs and rafters. By th arrangement there are no slack places around the plate to admit cold air The end walls are packed in the same way. The house is divided by clos board partitions into seven 20-foot sections; and one 10-foot section is reserv at the lower end for a feed storage room.

Each of the 20-foot sections has two 12 light, outside windows screwed ont the front, and the space between the windows, which is 8 feet long and 3 fe wide down from the plate, is covered during rough winter storms and col nights by a light frame covered with 10-ounce duck closely tacked on. This doo or curtain is hinged at the top and swings in and up to the roof when open.

A door 2½ feet wide is in the front of each section. The roost platform is a *the back* side of each room and extends the whole 20 feet. The platform

3 feet 6 inches wide and is 3 feet above the floor. The roosts are of 2 by 3 inch stuff placed on edge and are 10 inches above the platform. The back one is 11 inches out from the wall and the space between the two is 16 inches, leaving 15 inches between the front roost and the duck curtain, which is sufficient to prevent the curtain being soiled by the birds on the roost. The two curtains in front of the roost are similar to the one in the front of the house. They are each 10 feet long and 30 inches wide, hinged at the top, and open out into the room and fasten up when not in use. Great care was exercised in constructing the roosting closets to have them as near air-tight as possible, excepting what may be admitted through the cloth curtain.

Single pulleys are hung at the rafters and, with half inch rope fastened to the lower edge of the curtain frames, they are easily raised or lowered and kept in place. At one end of the roosts a space of 3 feet is reserved for a cage for broody hens. This being behind the curtain, the birds have the same night temperature when they are transferred from the roosts to the cage. Six trap nests are placed at one end of each room and four at the other. (Fig. 2.)

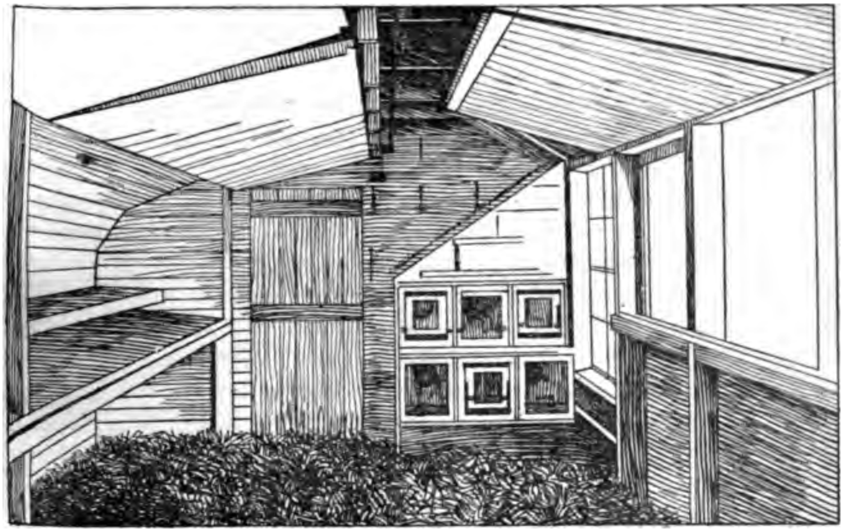

FIG. 2.—Interior of one section of curtain-front house, showing also trap nests in one corner.

They are put near the front, so that the light may be good for reading and recording the number on the leg bands of the birds. Several shelves are put on the walls 1½ feet above the floor for shell, grit, bone, etc. The doors which admit from one room to another throughout the building are frames covered with 10-ounce duck, so as to make them light. They are hung with double-acting spring hinges. The advantages of having all doors push from a person are very great, as they hinder the passage of the attendant with his baskets and pails very little. Strips of old rubber belting are nailed around the studs, which the doors rub against as they swing to, so as to just catch and hold them from opening too easily by the wind. Tight board partitions were used between the pens instead of wire, so as to prevent drafts. A platform 3 feet wide extends across both ends and the entire front of the building outside.

The house is well made of good material and should prove to be durable.

It costs about $850. A rougher building with plain instead of trap nests, with the roof and walls covered with some of the prepared materials, instead of shingles, could be built for less money, and would probably furnish as comfortable quarters for the birds for a time as this building will.

This house accommodates 350 hens—50 in each 20-foot section.

Even in very severe weather when the temperature at night was considerably below zero and rose but little above it during the day, with high winds, the bedding on the floor and the roosting closets remained dry and free from offensive odors. The fowls laid as well as their mates in a large warmed house, their combs were red and their plumage bright, and they gave every evidence of perfect health and vigor. "The birds seemed to enjoy coming out of the warm sleeping closet down into the cold straw, which was never damp, but always dry, because the whole house was open to the outside air and sun every day. There were no shut-off corners of floor or closet that were damp." No cases of cold or snuffles developed among the fowls.

It is customary to have the yards on the south or sheltered side of poultry houses to afford protection during late fall and early spring, when cold winds are common. With the curtained-front house north yards only are to be used, it being believed that the necessity for getting the fowls as soon as possible out of the open-front house where they are really subject to most of the out-of-door conditions during the daytime is not so great as when they are confined in closed houses with walls and glass windows. "The clear open front of the house allows teams to pass close to the open door of the pens for cleaning out worn material and delivering new bedding, and also in allowing attendants to enter and leave all pens from the outside walk, and reach the feed room without passing through intervening pens."

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COLLEGE
San Francisco, Cal.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 228.

FOREST PLANTING AND FARM MANAGEMENT.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Forest Service,
Washington, D. C., August 8, 1905.

Sir: A paper on Forest Planting and Farm Management, prepared under my direction by Mr. George L. Clothier, of the Forest Service, and published in the Yearbook of the Department for 1904, is herewith submitted, with a few slight alterations, for republication as a Farmers' Bulletin.

Respectfully,
Gifford Pinchot,
Forester.

Hon. James Wilson,
Secretary of Agriculture.

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FOREST PLANTING AND FARM MANAGEMENT.

FORESTRY AND FARM DESIGNING.

Although agriculture stands first among American industries and our production of farm products is greater than that of any other country, the possibilities of the art of agriculture have hardly begun to be understood. That scientific farming will vastly increase the productive power of the land in the United States is beyond doubt. With the advance of knowledge through the discovery of new truths and the advance in practice through the better application of what science has already found out, improved utilization of the country's resources will make room for a future rapid growth in population and wealth, as expansion in territory has made room in the past. Making the same land twice as productive as before is as good as doubling the amount of land, if not better, and we have as yet scarcely scratched the surface of the agricultural resources of the country as a whole. One of the ways in which present methods of farm management may be greatly improved is by better recognition of what may be called farm engineering, or farm designing; and this in turn must give an important place to the consideration of farm forestry.

The farm designer, or farm architect as he might be called, can do much to improve the efficiency of farm operation. Economical management may be attained by a scientific adjustment of the parts of a farm, just as the utility of a great building may be increased by the careful planning of a qualified architect. Several agricultural colleges and experiment stations have recognized this fact, and have given a distinct place to this as a part of the great problem of how to get the most out of the soil. The best opportunities to apply these principles are found in those parts of the West where new farms are being taken up. Generally it is also in these regions that forestry can do most for the farmer, for in the treeless regions, especially, the full development of the country depends in no small degree on the establishment of forest plantations.

From the fact that trees take so much time to grow, the forester who seeks to advise a farmer how he can make trees contribute most largely to his prosperity is compelled to take a long look ahead and to consider the whole problem of farm arrangement. In well-settled regions the possibilities of farm designing are apt to be severely limited by what has been done in the past. The location of the buildings, the division into fields, and in many cases the situation of the timber, are now fixed facts. Nevertheless, even here a decided improvement may often be made, as will be illustrated later. What needs to be emphasized now is that even in the older parts of the country a farm should be run according to a definite and carefully considered plan, designed to secure economy of operation and the best use of every part; that tree planting for farm purposes ought always to take into account this plan; and that even where standing timber is already present it may be in the interest of the best use of all parts of the farm to cut this down and plant elsewhere.

THE NEED OF FOREST PLANTING.

Forests are indispensable to the highest material development of any country. We have learned that, besides furnishing the useful timber products resulting from the growth of trees, they conserve moisture, ameliorate climatic extremes, and purify the atmosphere. Where they are not found naturally, or where they have been thoughtlessly removed from wide stretches of country, it becomes desirable in behalf of the public welfare to plant trees in great number. Obviously the benefits of such plantations will be most widely felt if the planting is well distributed over the region. Further, it is a work the benefits of which are shared by all, and which all should join in performing.

The plantations in a definite region should be made after one general plan, in order to allot to each farm its proportionate amount of forest. The method of planting and the position of the planting sites should evidently be made with reference to a system of farm management, since a forest is the most permanent thing that can be planted on a farm. An example of such a plan and such a system is shown in fig. 1.

MISTAKES OF THE PAST.

It is unfortunate that a large percentage of the plantations made by farmers have been disappointing. Yet some commercial plantations, such as that of Mr. L. W. Yaggy, at Hutchinson, Kans., have been financially successful.

Farm forest planting has been practiced in some of our prairie States for more than half a century, and great good has resulted from many of the plantations, but the measurable increase in the wealth of the country attributable to forest planting has been small, owing to the choice of poor sites and the use of unsuitable species. The artificial forests of Illinois would have been worth many times what they are at present if longer-lived and more valuable species had been used in the plantations instead of silver maple or other trees of as little worth. Species of the greatest value have often been ignored because of their slow growth, and others, deserving to be classed as "weed trees," have been used in their place. Successful plantations of black walnut, hickory, elm, oak, and other valuable trees are common enough to prove that the slower-growing woods ordinarily pay best. Silver maple, boxelder, and the like are valuable chiefly for firewood, and it is easily possible to overstock the market for cordwood in any locality. Lumber woods, on the other hand, can always be disposed of in any quantity.

In order to illustrate the relative values of the two classes, let a comparison be made between the returns from a 64-year-old stand of black walnut in Morgan County, Ill., and a 35-year-old stand of silver maple in Sangamon County. These were the best groves of each species found in the State during an extended survey made in the summer of 1904. The figures relating to the two tracts may be best contrasted in the following table:

Value of planted forests of black walnut and silver maple on the prairies of Illinois.

Species.	Location.	Age.	Area.	Number of trees on area.	Average diameter breast-high.		
					Dominant trees.	Intermediate trees.	Suppressed trees.
		Years.	*Acres.*		*Inches.*	*Inches.*	*Inches.*
Black walnut	Morgan County, Ill	64	0.6	119	19.0	13.3	9.4
Silver maple	Sangamon County, Ill	35	5.6	1,478	10.6	....	....

Species.	Location.	Number of trees per acre.	Yield per acre.			Total value per acre.[b]	Annual value per acre.[c]
			Lumber.[a]	Fence posts.	Firewood.		
			Board ft.		*Cords.*		
Black walnut	Morgan County, Ill	198	42,000	1,800	15	$1,050	$5.58
Silver maple	Sangamon County, Ill	264	....	....	65	130	2.15

[a] From trees 11 inches and over in diameter breasthigh.

[b] Lumber at $20 per 1,000 board feet, fence posts at 10 cents each, and firewood at $2 per cord.

[c] Interest compounded annually at 3 per cent.

It would be quite as easy to show that the returns from hickory, elm, or some other wood which can be used when no older than the maple would amount to more than those from the latter, but the comparison of walnut with maple serves also to emphasize the greater value of a wood which must be kept until the trees attain a good size. The figures in the last column represent the annual returns from the two plantations irrespective of their age, and are therefore directly comparable.

It is a well-known fact that the great majority of the forest plantations made in accordance with the timber-culture act were failures. Here, again, the unfavorable results were due to poor sites and ill-adapted species, combined with a lack of care on the part of planters and the dishonesty of entrymen, who regarded this law merely as a means of obtaining title to public land without paying for it.

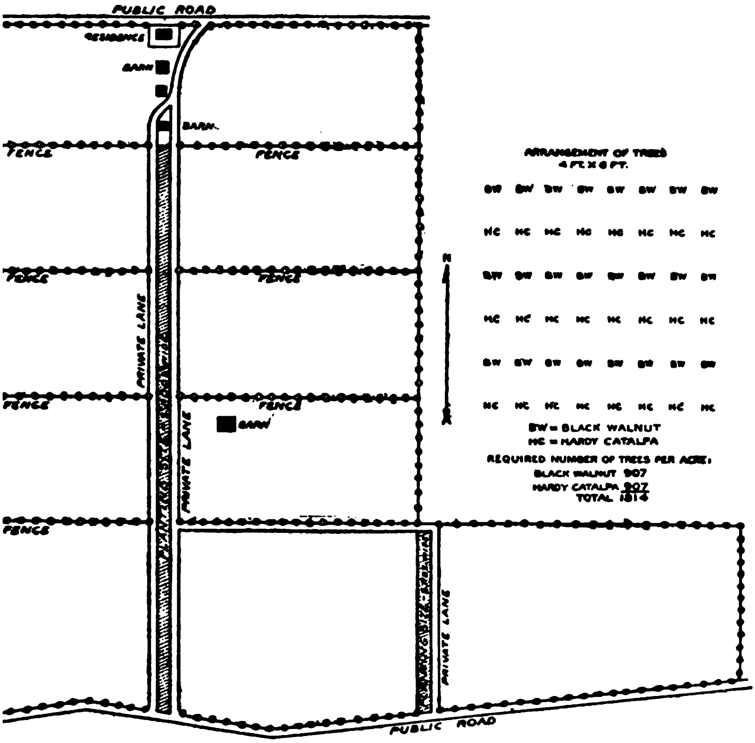
Plantations made by specialists and designed for a special purpose do not usually require very elaborate planting plans. It is the small woodlot plantation that is to serve many purposes in the economy of the farm which calls for the most careful planning.

PREPARATION OF A PLANTING PLAN.

As a machine of production, a farm should have a plan which provides for the best use of its every part. The woodlot or forest plantation should be in a position to contribute to the successful operation of this plan, for the trees may affect the atmospheric drainage, the wind currents, and the humidity of the air about the home. At the same time a planting plan must provide for sites which will produce the best possible growth. The arrangement of the fields and the location of the fences, private lanes, drainage systems, buildings, and farmstead should all be considered before any forest planting is undertaken.

Very rarely indeed have farmers deliberately planned the location and make-up of their forest plantations with reference to the needs, convenience and economy of their farms, and the relative value and adaptability of the trees to be planted. Woodlots have sometimes been so poorly located as to do actual damage to farms. Cases have been observed in the northern half of the Middle West where windbreaks planted too close to the buildings caused the drifting snow of severe winters to bury the houses 15 or 20 feet deep. In the winter of 1899 a farmhouse in the Red River Valley, North Dakota, was buried in a snowdrift for three months because a cottonwood grove had been planted too near it. In other cases trees have been planted near tile drains, which the roots clog.

It is probable that not one-tenth of American farms are being operated under any permanent system of management. Before forest planting is undertaken some such system must be adopted, however, in order to make the future existence of the forest plantations possible, for more than half the planting plans made since July 1, 18[illegible], Forest Service, fundamentally affect the future management arms. As very few farmers are accustomed to formulating ans, the agent of the Forest Service, besides being called give advice in matters pertaining to technical forestry, is drafted into this service as well. After consultation with holder and consideration of all the matters affected by the f management, he is able to bring out an orderly arrange- ich will permit on the same farm the practice of both scien- iculture and scientific forestry.



rangement of forest plantations on a farm in central Ohio to facilitate scientific farm management.

A CONCRETE EXAMPLE.

lanting plan shown in fig. 1 was made for a farm in central d illustrates graphically the bearing that forest planting may the management of a farm. This farm in Ohio contains 375 d that part of it which is devoted to agriculture is capable of interest on a capitalization of $100 per acre; not a foot of it ted to tillage. That part which was originally heavily tim- s all been cleared, except a blue-grass pasture of 30 or 40 acres which is occupied by the remains of the original forest, consisting of a scattered stand of declining sugar maple and beech trees. This timberland embraces the most fertile part of the farm, and interferes most seriously with the convenient and economical division of the farm into fields. If the Forest Service had advised the owner to attempt to rejuvenate the dying trees and to underplant them with expensive nursery stock, the instructions would have been implicitly followed, but such advice would have wrought a positive injury to the landholder. Instead, the planting plan advises that the forest area of the farm be reduced by clearing the only natural timber left standing, and that, instead of retaining the scattered growth now cumbering the pasture, trees sufficient to occupy about half the present forest acreage be planted in such positions as to protect the farm from the severe westerly winds prevailing in the region.

The owner was therefore advised as follows:

(1) The major part of this farm is too valuable for agricultural purposes to be devoted to forestry. The native timber now scattered over the pasture is rapidly declining, and is reduced by every hard storm. No natural reproduction is taking place, and while the land is grazed none can be secured. The location of the scattered trees in the middle of the farm would require expensive fencing in order to protect them from live stock. Thus, it is believed that the rejuvenation of the old forest on this farm is impracticable. Instead, this land, as soon as the old trees have all disappeared or been removed, should be laid out into permanent fields. As every well-regulated farm, however, should possess some timber land to supply it with fence posts and to furnish shade and shelter for live stock, new plantations are recommended. The trees will take up as little room as possible, while the arrangement of the fields in rectangular blocks will greatly facilitate the use of modern machinery.

(2) The chief plantations should occupy strips 5 rods wide, running from north to south. One of these strips should be planted on the western border of the farm and another crossing its center due south of the residence. A third should cut off the block extending east from the southeast corner of the main rectangular tract. In addition to these strips, it is advised that single rows of trees be planted on the division lines between the fields, so that they may be used as live posts upon which to fasten wire to form fences. (See fig. 1.)

(3) Black walnut and hardy catalpa should be used in equal proportions for the belts, and should be planted every 4 feet in alternating rows, which should be 6 feet apart. The walnut seed should be planted two years prior to the introduction of the catalpa seedlings, in order to allow the slow-growing walnut to get a start before being

crowded by the catalpa. The nuts of the walnut should be collected as soon as ripe in the fall, and should either be stratified[a] in moist sand or planted immediately in their permanent site. These nuts should never be allowed to dry out after ripening. They are most easily planted while plowing, by dropping them in a furrow and covering them with the next furrow slice. If walnuts are thus planted, the squirrels are not likely to find them. The ground between the rows during the following two years should be planted with corn, and should receive good tillage. This can best be done by use of the lister. After the catalpa seedlings are introduced no more corn should be planted, but the ground should be cultivated as long as a single-horse cultivator can be run between the rows. Catalpa seedlings 12 to 16 inches tall and one year old should be used. They can be obtained from dealers for $1.50 to $5 per thousand. The labor of planting these seedlings may be performed chiefly by horsepower. Both walnut and catalpa should be planted in accordance with the diagram shown at the right in fig. 1.

By consulting the illustration the reader will see that the planting plan subdivides this farm into eleven fields—eight rectangular ones of equal area and similar dimensions, and three of nearly equal area but of unlike dimensions. This division will permit the application of scientific crop rotations, the eight rectangular fields being suited to two systems of four-year rotations and the three irregular fields to one three-year rotation. The convenient shape, ease of cultivation, and wonderful fertility of this farm present an excellent opportunity for the arrangement of such rotations of suitable crops.

Trees planted on the lines which separate the fields will serve as windbreaks as well as living fence posts. A method adopted by some is to plant Osage orange hedges between the fields, and every 20 feet to allow one of the trees to grow to its natural height. The remaining trees should be pruned to a height of 5 feet and kept within proper limits for a hedge. Then, if this growth proves inefficient as a fence, it can be reenforced by fencing wire stapled to the large trees. If the Osage orange is undesirable or a hedge is not wanted, chestnut should prove a desirable tree for the fence lines. The young trees should be planted about 20 feet apart, and when they begin to crowd each other every alternate tree should be cut out. Round-headed and with sturdy trunks, these trees will form very effective windbreaks for the intervening fields. Their nuts will bring a satisfactory return for the land they occupy, and the trees which are cut out will furnish excellent fence posts. The substitution of straight woven-wire fences for the old zigzag ones of rails transforms the fence lines from breeding places for noxious weeds into productive land upon which the living fence posts grow into a merchantable product.

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[a] Stratification is a method of storing forest seeds to prevent them from drying out. The seeds are stored in alternating layers between layers of moist sand.

Such a plan as this fixes the boundaries of the fields, locates the private lanes, and, in fact, forms the skeleton of any future system of farm management that may be applied to this farm.

A MODEL PRAIRIE FARM PLAN.

In order to illustrate a model prairie farm plan made in accordance with sound principles of forestry, fig. 2 has been prepared. This farm plan is applicable to a large region in the prairies of the Middle Vest, where windbreaks are necessary to the full development of the untry. It assumes that the land is of uniform condition of soil, nd has been surveyed by the rectangular system adopted by the overnment. The public roads are supposed to be located on the section lines. The application of this model to a country with its

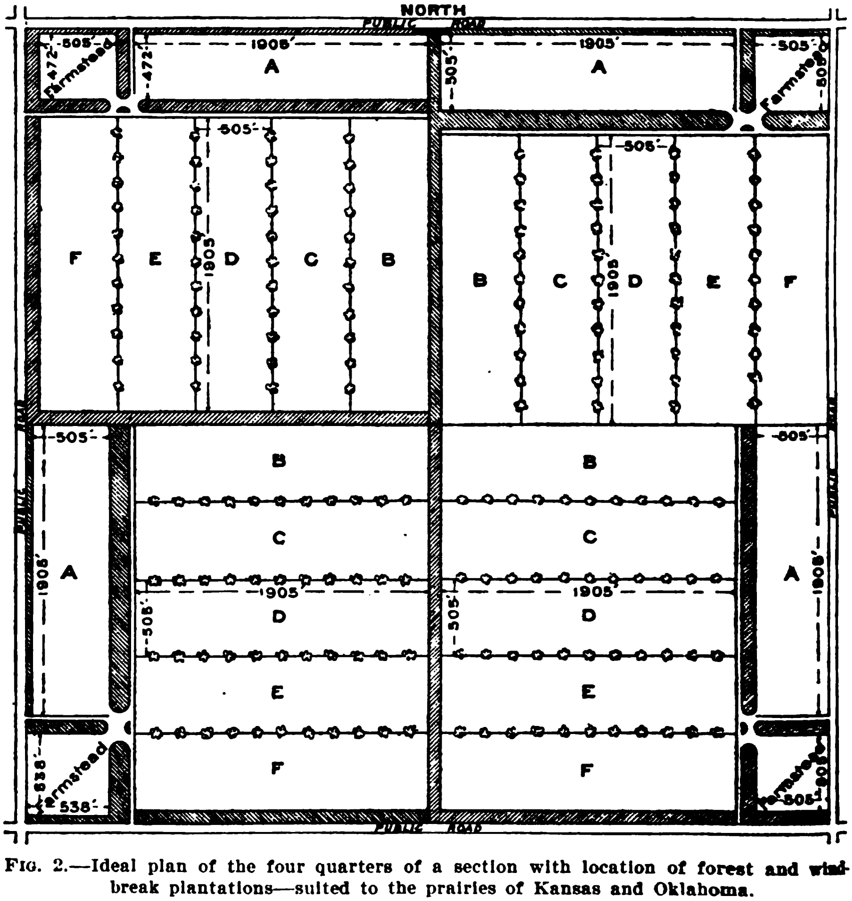


FIG. 2.—Ideal plan of the four quarters of a section with location of forest and windbreak plantations—suited to the prairies of Kansas and Oklahoma.

surface broken by creeks or lakes would, of course, necessitate a modification to fit local conditions. The plan is intended merely to illustrate principles.

Four farms of 160 acres each are shown, illustrating an arrangement suitable to each of the four quarters of a section. The farmstead, or that portion of a farm which is occupied by the residence, barn, orchards, gardens, lawn, and feedlots, is here shown as placed at the section corner of each farm. While in a large proportion of cases the location of the farmstead will be determined by the particular conditions, as water supply, topography, etc., an arrangement, where practicable, by which the houses stand on the section corners will be worth considering.

The fields on each quarter section have been laid out to permit the planting of windbreaks to protect the crops from the hot southwesterly winds of summer and the cold northwesterly winds of winter. The farmsteads are also provided with protection from winds. East winds have not been considered, because of their infrequent occurrence, but a general adoption of this plan on all the farms of a region would afford protection from all points of the compass.

The fields, with one exception, are all of the same shape and size, there being on each quarter section six fields, each 22.1 acres in area. This method of dividing the farm into fields will afford an opportunity for the application of a scientific system of crop rotation. and the fields, being six in number, will permit the application of a compound rotation embracing the use of a perennial crop like alfalfa in combination with five annual crops, where this is desired. If the use of a perennial is not desirable, the six fields will permit the running of two parallel three-crop rotations.

TREES AND METHODS RECOMMENDED.

The plan provides that the forest trees shall be planted in belts varying from 2 to 8 rods in width, except along fence lines, where they are in single rows. The best results, purely from the standpoint of forestry, will be obtained in the widest belts, since trees are social in their habits. Still better tree growth would be secured by planting in compact blocks. But as agriculture is the fundamental industry in the region to which this plan applies, the tree planting is designed only to supplement the production of field crops. Eleven or 12 per cent of each quarter section is to be devoted to forest. This is exclusive of the space occupied by the single lines of trees in the fence rows.

The species that may be recommended for this purpose vary for each particular locality with conditions of climate, rainfall, and soil. Considering the Middle Western States together, however, the following trees, when placed on hospitable soil fulfilling the requirements of each individual species, may, in the northern half of the region, be successfully grown as windbreaks:

Arborvitæ.
Green ash.
Boxelder.
Cottonwood.
Cork elm.
White elm.
European larch.
Russian wild olive.
Western yellow pine.
Black Hills spruce.
Laurel-leafed willow.
Russian golden willow.
White willow.

In the southern half of the Middle West, also the green ash, cottonwood, white elm, Russian wild olive, and western yellow pine may be successfully grown, and in addition the following species:

Chinese arborvitæ.
Wild China.
Black locust.
Honey locust.
Mesquite.
Russian mulberry.
Osage orange.
Persimmon.
Shittimwood.

These lists do not include all of the best timber trees that might be grown in the Middle West, for many valuable timber trees will not endure such severe exposure as a windbreak is subject to.

In the establishment of a windbreak wisdom is required in the placing of the different species. A windbreak composed of more than one species is usually the most effective. An excellent method of arrangement is to place the shortest trees in the outside row (toward the prevailing wind), to plant a somewhat taller species next to them, and to place the tallest trees in a third row on the side adjacent to the buildings or the area which is to be protected. This causes the wind to strike the trees as it would strike the face of a steep hill, deflecting its course upward. If the tallest trees of the third row consist of a flexible species, such as cottonwood, European larch, white willow, or honey locust, they will bend before the wind, and act as a cushion to deflect it upward and over the object to be protected. A satisfactory windbreak 5 rods in width, for the protection of the north and west sides of a farmstead (see fig. 2) and adapted to Minnesota and the Dakotas, is as follows: Plant 13 rows of trees, parallel to one another and 6 feet 10 inches apart. The first two rows on the north and west edges of the belts should consist of Russian wild olive, the third and fourth rows of arborvitæ, the fifth and sixth rows of boxelder, the seventh and eighth rows of white elm, the ninth and tenth rows of white willow, and the remaining three rows of common cottonwood. Such a plantation, when mature, will appear like a wall with a sloping top, the highest side being where the cottonwoods are planted.

Carrying out this same principle for Oklahoma and Texas, with a change in the position of the plantations to afford protection from southwest winds (see fig. 2), the following method is advised: The first two rows on the south and west edges of the belts should consist of Russian mulberry or Osage orange, the third and fourth rows of Chinese arborvitæ, the fifth and sixth rows of black locust, the seventh and eighth rows of green ash, the ninth and tenth rows of white elm, and the remaining three rows of honey locust or common cottonwood.

In southern California, where the damaging winds come from opposite points of the compass (from both the southwest and northeast), a good plan for a windbreak is one in which the tallest, most flexible trees will be in the center rows, so that the species on either side will slope downward toward the outside edges of the belt. For such a windbreak 2½ rods wide and consisting of 7 rows of trees, the following arrangement may be suggested: The three rows in the middle of the belt should be of blue gum (*Eucalyptus globulus*), the next row toward the outside on each side should be of Monterey pine (*Pinus radiata*), and the two rows occupying the two edges of the belt should be of Monterey cypress (*Cupressus macrocarpa*). This same arrangement may be used on a belt 5 rods wide by doubling the number of rows of pine and cypress and increasing the gum to five rows. In order to construct a windbreak in California that will be perfectly effective, the belts should be placed on all four sides of the area which is to be protected. This is illustrated by the farmstead on the northwest quarter of the section shown in fig. 2.

The belts advised in the model plan are of sufficient width to produce all the timber that will be needed on a farm of 160 acres, while the fields are sufficiently narrow to be protected from winds by the single lines of trees occupying the fence rows. Experiments have demonstrated that a windbreak, on level land, will be effective for a distance of at least ten times its height. For perfect protection on the model farms herein described, the trees in the windbreak must reach a height of at least 50 feet.

An objection to growing trees along fence lines has been made by farmers on the ground that such trees steal the soil nourishment from the crops which are on the edges of the fields. It is true that healthy, vigorous trees make great demands on the soil moisture in their immediate vicinity, but wherever their influence is felt as windbreaks they conserve enough moisture, by preventing rapid evaporation, to more than pay for all that they use. By planting a deep-rooted crop like alfalfa under the shade of the fence-line trees, good returns from the land may be secured in spite of the fact that the trees absorb a part of its moisture. It is a great mistake to begrudge a useful tree the space it occupies, and particularly so in the naturally treeless prairies of the Middle West.

SPECIAL FEATURES OF FOREST PLANTING ABOUT THE FARMSTEAD.

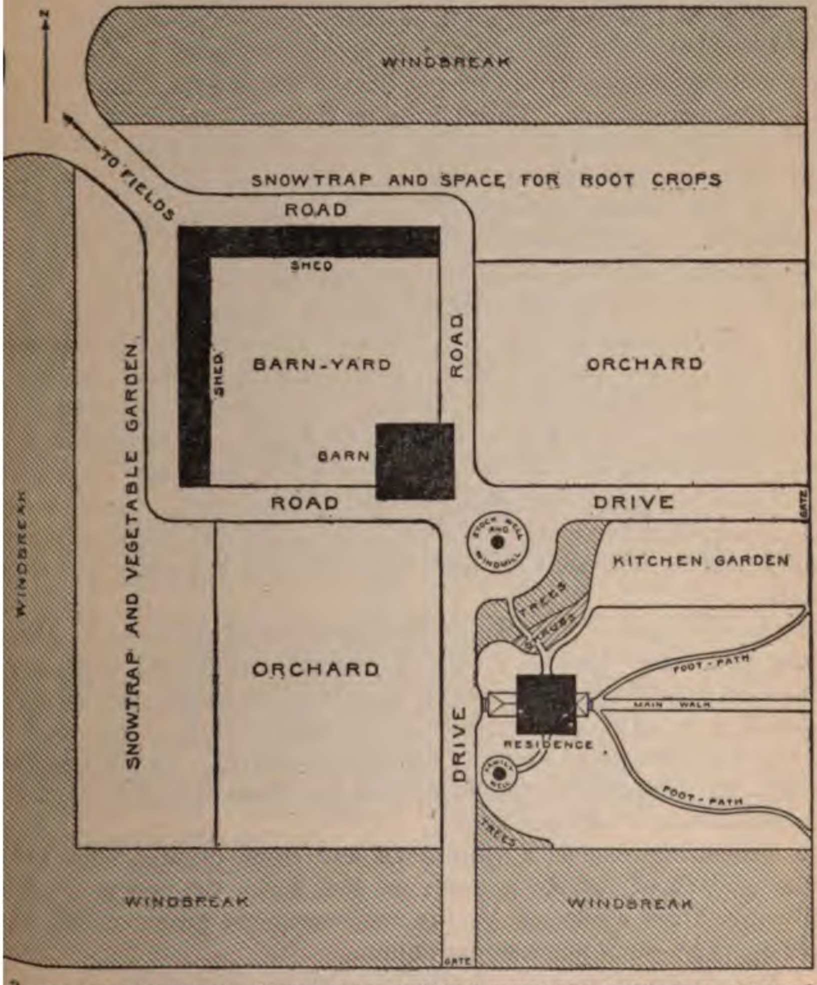
On rare occasions it is found to be impracticable to concentrate the different elements of the farmstead in one place. (See fig. 3.) In the great majority of cases, however, it is both practicable and economical to have a farmstead, and the choice of its site is of the first importance to the landowner.

If the farmsteads of several adjoining sections were laid out in accordance with the plan herein suggested, four farmhouses would be grouped at each crossroads corner, bringing neighbors together in a little settlement. The position at the crossroads is also likely to facilitate the reaching of church, school, and town. An argument against such an arrangement is the possibility of its leading to neighborhood quarrels.

In many cases, however, uniformity of soil does not exist. The farmstead must then be located with reference to the adaptability of the soil to the forest growth, since a farmstead without trees for shade and shelter is not worthy of the name. The forest planter, therefore, is often the one to determine the location of a permanent site for the farmhouse, and he may also lay out at least the plan of the farmstead itself.

Fig. 3, representing the farmstead located on the southeast quarter of the section sketched in fig. 2, has been prepared to show how forest planting may be made to help every one of the different parts that go to make up the farmstead. Windbreak belts, 5 rods wide, are located on the north, west, and south sides of the farmstead. Open spaces varying from 72 to 96 feet in width have been provided to the north and west of the buildings and orchards, to act as snow traps to catch the drifts during winter storms. Every farmer is familiar with the fact that a hedge or belt of trees on the north side of an east-and-west road will cause the road to be filled with snow during winter, when the wind comes from the north. So the open space on the farmstead will in the same way trap the snow, and will consequently prevent any drifts from forming near the barn or residence or in the orchards. These open spaces may be utilized for garden vegetables, sugar beets, and other annual feed crops, the accumulation of winter snows serving as an annual irrigation to store up large quantities of soil moisture for the garden, and making the land particularly well adapted to this purpose. The trees on the edges of these spaces will, for the same reason, grow very vigorously.

In this plan the convenience, health, and comfort of the tenants of the farmhouse have all been considered in the location of both barn and residence. The grouping of the trees in the background of the n has been made with reference to adornment, but without an mpt to enter into the details of landscape gardening. The plan es the lawn in such a shape, however, that the landscape garer may have full scope for the display of his talents. A plan uding, as this one does, complete protection from the hot winds of mer and the cold storms of winter will add greatly to the intrinsic



3.—Plan of a farmstead, situated at the southeast corner of a prairie farm, arranged to afford windbreak protection.

rth of any farm located in the prairie States. If the farmer is aged in the production of beef and pork, the protection of the nyard and feedlots will economize the feed consumed by the fating animals, for it takes more grain to produce a pound of flesh upon animals exposed to the cold north winds of winter than upon stock that is protected from blizzards. Thus a windbreak takes the place of grain in maintaining the heat of the animal during cold weather. On the other hand, it will add to the farmer's bank account during the summer, for it will afford shade and protection to fattening animals, which lose flesh in very hot weather.

Windbreak belts in connection with a farmstead form an asset that is none the less real because the actual money value may not easily be determined. The protection to an orchard afforded by forest trees is valuable, since late frosts are not likely to blight the fruit blossoms of a protected orchard. Forest belts on the south and west sides of the farmstead give ample protection against the parching blasts from the southwest—the hot winds of summer, which are destructive to fruit in many parts of the country. It is to be understood, however, that the forest plantations herein recommended are also to be utilized for the production of the needed timber supplies on the farm. By judiciously thinning the plantations, 20 acres of planted forest will furnish all the fuel needed on a farm of 160 acres, besides producing lumber for the renewal of the farm buildings. Many Kansas and Nebraska farmers have in twenty years grown cottonwood trees large enough for sawlogs. Mr. W. D. Rippey, of Severance, Kans., cut 200,000 feet of cottonwood lumber a few years ago from trees of his own planting. Mr. Rippey's plantations were on uplands where the soil is not particularly well adapted to the growth of cottonwood, and, when lumbered, were but little more than a quarter of a century old.

On the farm of Mr. T. F. Eastgate, near Larimore, N. Dak., in the Red River Valley, a belt of planted cottonwood trees, supplemented by a dense undergrowth of wild plum bushes, acts as a windbreak and snow catcher, causing a snowdrift to form in winter over the open field, which is devoted to alfalfa. In the summer of 1904 Mr. Eastgate harvested alfalfa hay from this field at the rate of more than 5 tons per acre.

Besides serving as a windbreak and snow catcher, thus making the growth of alfalfa possible on this farm, the forest plantation has produced cordwood during its twenty-one years of life at the rate of 4.74 cords per acre per annum.

The successful growth of alfalfa on 10 per cent of the area of this region would double the earning power of every acre of land in the Red River Valley; and, since the thermometer here sometimes falls as low as 50° below zero, it is possible to grow this extremely valuable forage only by utilizing some contrivance like Mr. Eastgate's windbreak, to catch the snowdrifts and form during the winter a protecting blanket over the plants.

CONCLUSION.

Forestry is but a branch of the great industry of agriculture, but it can give important aid to the farmer in getting sustenance for the human race from the soil. It has been shown that where forest planting is desirable, the planting plan is of fundamental importance to the management of the farm which is concerned. The location and cultivation of these forests may either make them peculiarly advantageous or cause them to become a detriment to the economical management of the farm.

The planting plans which have been set forth in the preceding pages are not regarded as perfect, but are given as suggestions of what may be done to make farm forest planting serviceable. They are based on considerable practical experience, and it is believed that they demonstrate beyond a doubt how far superior is a well-considered, systematic method of handling the problems of farm forestry to the haphazard, careless methods so often practiced in the past.

Farmers are now receiving instructions from the Department of Agriculture both for the establishment of forest plantations and for the inauguration of cropping systems, but it seldom happens that the same farmer receives instruction in both matters at the same time. The intimate relations existing between farm management and forest planting are so patent and their importance is so great that the two should go hand in hand. It is to be hoped that as the practice of scientific agriculture spreads, model farms may be laid out in all parts of the United States, on which practicable plans for forest planting may be demonstrated and the best methods of planning the various parts of a farm so as to make provision for an economical and practicable system of crop rotation may be illustrated. Farmers, in order to get the services of Government experts in planning both forest plantations and systems of farm management, should make application for instructions both to the Bureau of Plant Industry and to the Forest Service.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

No. 22. The Feeding of Farm Animals. No. 24. Hog Cholera and Swine Plague. No. 25. Peanuts Culture and Uses. No. 27. Flax for Seed and Fiber. No. 28. Weeds: And How to Kill Them. No. 29 Souring and Other Changes in Milk. No. 30. Grape Diseases on the Pacific Coast. No. 31. Alfalfa or Lucerne. No. 32. Silos and Silage. No. 33. Peach Growing for Market. No. 34. Meats: Composition and Cooking. No. 35. Potato Culture. No. 36. Cotton Seed and Its Products. No. 37. Kafir Corn: Culture and Uses. No. 38. Spraying for Fruit Diseases. No. 39. Onion Culture. No. 41. Fowls: Care and Feeding. No. 42. Facts About Milk. No. 43. Sewage Disposal on the Farm. No. 44. Commercial Fertilizers. No. 45. Insects Injurious to Stored Grain. No. 46. Irrigation in Humid Climates. No. 47. Insects Affecting the Cotton Plant. No. 48. The Manuring of Cotton. No. 49. Sheep Feeding. No. 50. Sorghum as a Forage Crop. No. 51. Standard Varieties of Chickens. No. 52. The Sugar Beet. No. 54. Some Common Birds. No. 55. 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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 229.

HE PRODUCTION OF GOOD SEED CORN.

BY

C. P. HARTLEY,

Assistant in Physiology, Laboratory of Plant Breeding,
Bureau of Plant Industry.

WITH AN APPENDIX ON

SELECTION AND CARE OF SEED CORN.

BY

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Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
[illegible]

LETTER OF TRANSMITTAL

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 8, 1905.

Sir: I have the honor to transmit herewith the manuscript of a paper on the Production of Good Seed Corn, and to recommend that it be published as a Farmers' Bulletin.

This paper was prepared by Mr. C. P. Hartley, Assistant in Physiology, Laboratory of Plant Breeding, and has been submitted by the Pathologist and Physiologist with a view to publication.

Mr. Hartley's paper is intended for those who feel a sufficiently deep interest and who have adequate opportunities to make a specialty of producing high grade seed corn either for their own use or for sale. To this paper has been appended a brief discussion by Dr. Herbert J. Webber intended to be of use to those corn growers who do not feel that they can undertake special work in corn breeding and who may not be able to secure well-bred seed, but who desire to make the most of the opportunity to improve their corn by selecting seed from their field crops and taking proper care of the same.

Respectfully,
B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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THE PRODUCTION OF GOOD SEED CORN.

GENERAL DEMAND FOR WELL-BRED SEED CORN.

large number of letters are received by the Department of Agri-
ture containing such requests as the following:

ill you please inform me where well-bred seed of a variety of corn suited
is locality can be purchased?

he patient labors during the past century of James Riley, J. S.
ming, and James L. Reid, and the more recent work of other
breeders, have made it possible to answer satisfactorily such
iries from some localities, but the majority of the letters received
not be satisfactorily answered because no corn has been improved
the portions of the United States from which they come.

PROVED STRAINS NEEDED FOR DIFFERENT LOCALITIES.

trains of corn that doubtless had a common origin have become so
nged that some of them have a growing period of six months,
hing a height of 18 or more feet, while others ripen in ninety
s, having attained a height of only 2 or 3 feet. These changes
the result of selection, which is partly natural and partly the
k of man. By selection a strain can be greatly improved in pro-
tion and at the same time adapted to the soil and climatic condi-
s of the locality in which it is being improved. Because of
erences in soil, climate, and length of growing season, a corn
roved in one locality does not afford the best seed for localities
ch are unlike it. It is therefore essential that we have corn
ders in all sections of the United States.

AN OPPORTUNITY FOR PROGRESSIVE FARMERS.

n the opinion of the writer, the farmer who will produce a pro-
tive strain of corn adapted to his section will be able to sell good
l at a price profitable alike to himself and to those who buy, and
l become a public benefactor by increasing the production of corn
is neighborhood.

DESIRABLE EARS.

The most important character seed ears can possess is ability to reproduce abundantly a good quality of ears. The possession of certain other desirable characters can be determined by inspection, but this, the most important character, can be determined only by comparative growing tests.

There are many visible characters that a good seed ear should possess, and a corn having them, in addition to the character of great productivity, can be secured by selecting such ears from the progeny of those ears that yield most in the comparative production tests. The improvement of the visible characters of a corn is not as difficult as the improvement in power to yield abundantly, but both can be accomplished at the same time by persistent selection to type from the progeny of the most productive seed ears.

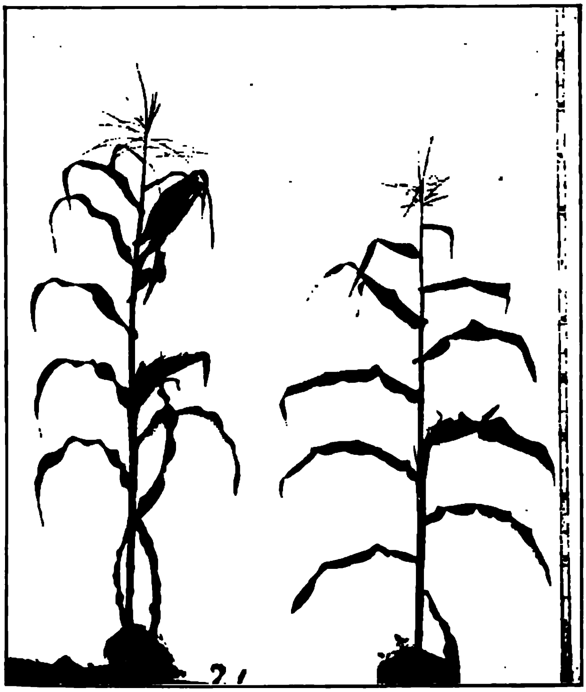

FIG. 2.—Two desirable stalks.

An ear of cylindrical shape, well rounded at each end, affords the largest percentage of grain per cob as well as kernels of the most uniform shape. The cob should be neither too large nor too small, and should possess the property of drying well and quickly, causing it to be of light weight and of a bright, healthy color. The kernels should fit compactly together throughout their full length on both sides and edges, and should be uniform in shape and length on all portions of the ear. Figure 3 illustrates the visible characters of a desirable seed ear. In poorly selected strains of corn undesirable ears of almost every possible size and form occur. Figure 4 illustrates a few undesirable points, such as grains of short and irregular shapes and a poorly developed butt and tip.

DESIRABLE KERNELS.

Length is a very desirable character for the kernels of a corn to possess, as it is by increased length in proportion to the diameter of cob that the percentage of grain is increased. Soft, chaffy kernels, though long, or kernels with prolonged chaffy caps, are not desired.

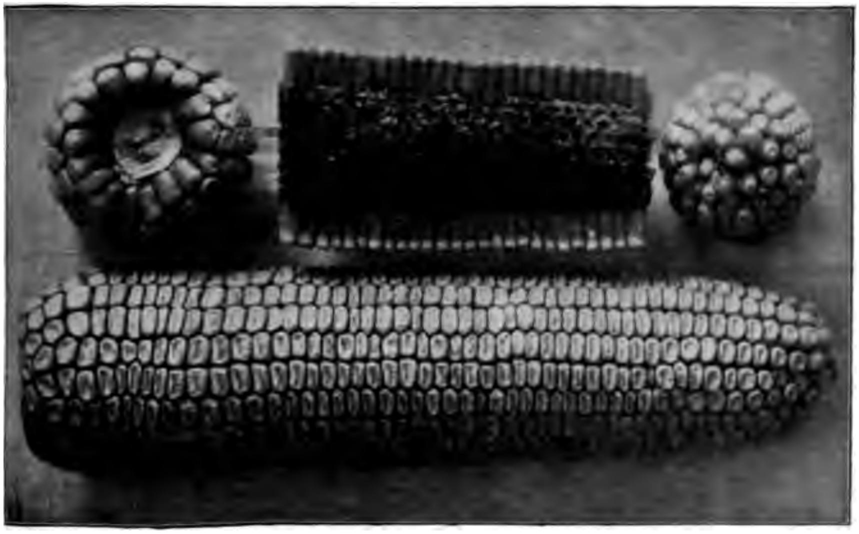

FIG. 3.—Two ears which possess excellent visible characters.

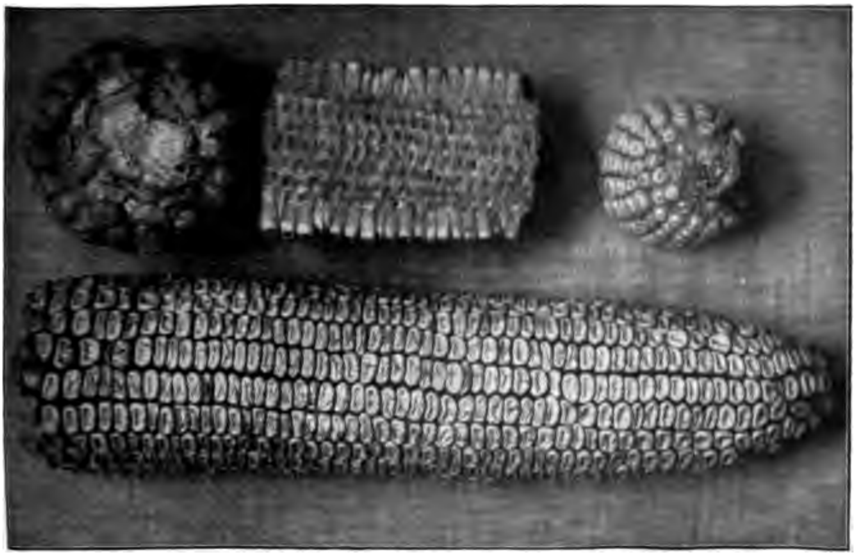

FIG. 4.—Two undesirable ears.

It is much better to select for increased length of **kernel than** to select for small cob. Selecting for small cob r size of the ear, and it is also an easy matter to reduce the size of the cob to such an extent that the pressure of the kernels causes the ear to break. Figure 5 shows some desirable kernels. The shape is that of a wedge having straight sides and edges. This shape admits of the kernels fitting together so compactly that little or no space is wasted. The germ, the most nutritious portion and the portion in which is located the embryo plant, should be large, smooth, and firm.

METHOD OF CORN BREEDING OUTLINED.

CHOOSING A CORN WITH WHICH TO BEGIN.

It is quite important that the work of breeding a productive strain should be begun with the best corn available. The experience of the farmers of a given locality is valuable in making this choice, and experimental tests made at the State experiment station may help to decide with what corn it is advisable to begin the work. If the soil or climatic conditions are peculiar, it is advisable to begin with a native strain that has become adapted to these peculiarities. If a uniform strain bred in some other locality proves as productive as or more productive than the native strains, it should be given the preference because of its better character.

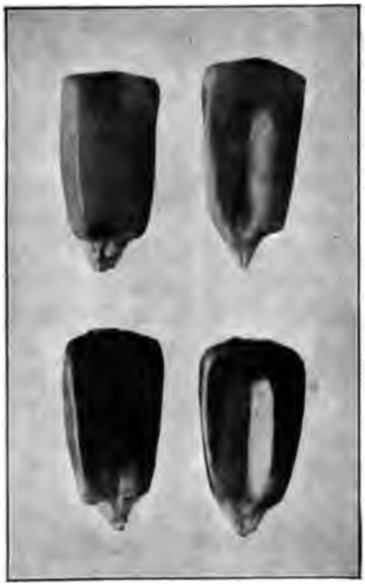

FIG. 5.—Desirable kernels.

SELECTION OF PARENT EARS.

The strain having been decided upon, the next step is to fix in mind the ideal stalk, ear, and kernel, and preserve for reference from time to time a sample ear that approaches most nearly to the ideal. A field of several acres in extent of the kind of corn chosen should be carefully gone through, and a hundred or more desirable ears selected from the most desirable stalks that can be found. This selection should be performed with the same care that an animal breeder would use in selecting sires and dams with which to begin a herd.

WHEN TO SELECT SEED.

If one feature desired be the production of an earlier corn the best time to perform the selection work is at the time the earliest stalks ripen and the ears begin to dry. Seed ears can then be taken from the earliest stalks, thus causing the strain to grow earlier from year to year. In the central and southern sections the corn can be allowed to become quite dry before gathering seed ears, but the work should not be delayed long after the corn ripens.

CLOSE EXAMINATION OF EARS SELECTED.

The hundred or more desirable ears which have been selected should be placed on boards or tables, with the tips of the ears pointing in the same direction. One by one each ear of the lot should be compared with the sample ear, which should be the one that most nearly approaches the typical ear, and any that do not conform to type should be discarded. Two or more kernels, one a third of the distance from the butt and another the same distance from the tip, should be taken from each ear and examined and measured. If these kernels are too short, or are found defective in any character, the ear should be discarded. Figure 6 shows a simple device that has proved exceedingly convenient in testing the length of kernels. It is made by cutting a notch in the thin portion of a shingle or in a piece of leather and tacking this piece on a table or box. The distance from the shoulder of the notch to a mark on a piece of paper placed beneath represents the length which the kernels must equal or exceed.

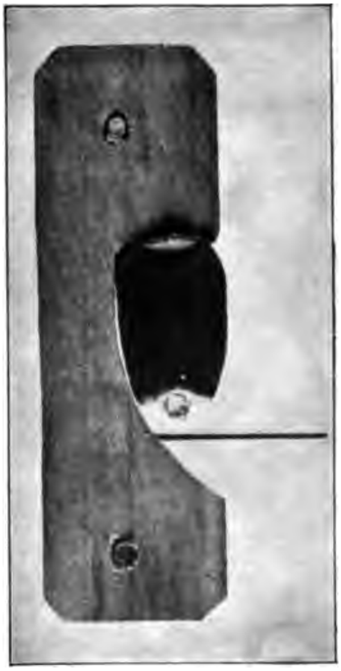

Fig. 6.—Convenient device for testing length of corn kernels.

The ears that have proved suitable should be thoroughly dried and well preserved till nearly planting time, when they should be shelled by hand, the poorly shaped kernels at the extremities being discarded and the good kernels placed in small paper bags, the kernels from each ear in a separate bag.

SELECTING A BREEDING PLAT.

In the breeding plat the best seed ears are planted in separate parallel rows, one ear to each row. This is necessary in order to determine which ears possess the invisible character of great productiveness to the highest degree. One who has never tried this method of planting would suppose that there would be little or no difference among the rows, but the characters of the ancestors reappear with surprising plainness. Figure 7 shows two rows planted from two ears of the same corn. The ear planted in row 118–2 was borne below the middle of the stalk, while the one planted in row 118–3 was borne above the middle. It will be noticed that this character has been transmitted to the stalks in these progeny rows.

Uniform soil necessary.—It is essential that the soil of the plat be uniform and that the various rows be given the same opportunity in all respects. Dead furrows and back furrows should be avoided. In case they are present, the rows should be planted at right angles to them; otherwise a row close to a dead furrow or back furrow might be placed at a great advantage or as great a disadvantage. If one side of the patch is higher than the other the rows should be planted so that each will have an equal amount of high and low land. These points are exceedingly important, for unless the rows all have an equal chance the results of the test become unreliable.

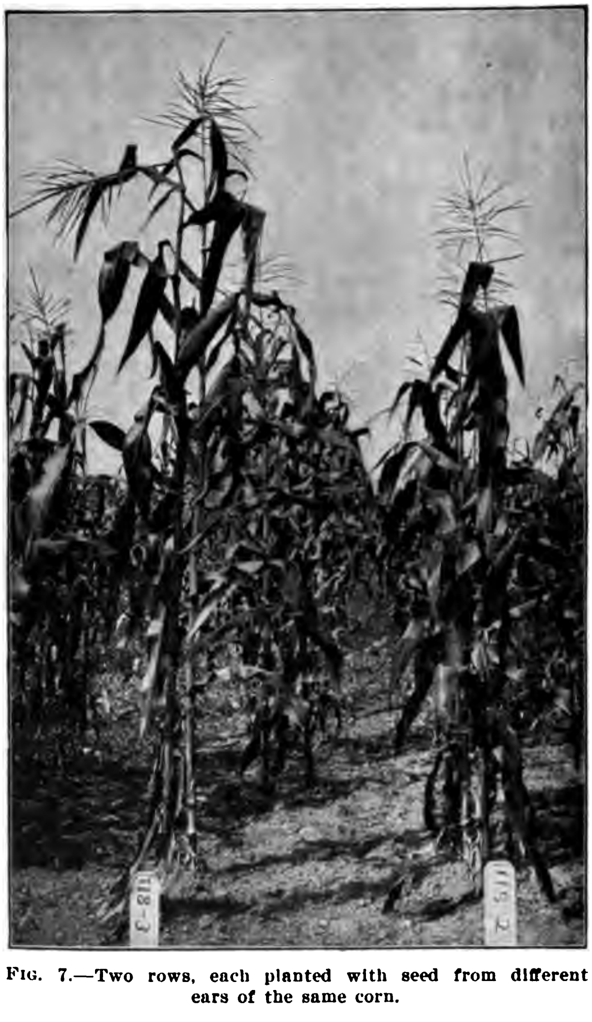

FIG. 7.—Two rows, each planted with seed from different ears of the same corn.

Soil should be characteristic of the locality.—The breeding plat should be located on land of the same nature and degree of fertility as the farm or the soil in general on which the seed produced in the breeding plat is to be planted. It is a mistake to give the seed plat extra care in the way of heavy fertilization or irrigation. The object of the breeding plat is to increase in a strain of corn the property of producing heavily under the natural conditions of the locality. This property is transmitted by selecting seed from the progeny of ears that give heaviest yields, not because of having grown on rich soil, but because of possessing an inherent tendency to great production. By locating the seed plat on soil similar to that of the neighborhood the strain of corn from year to year becomes better adapted to soil of that nature.

Isolation.—In all corn-breeding work isolation is essential. The breeding plat should be separated from other kinds of corn, and even from inferior strains of the same kind, by at least 40 rods. A greater distance is safer, though if strips of timber or hills intervene there is less likelihood of the winds carrying to the breeding plat pollen grains from inferior corns. The tasseling of volunteer corn stalks near the breeding plat must be prevented.

Size of plat.—The size of the breeding plát can be suited to the size of the farm and to the labor available for the work. From 40 to 60 corn rows of exactly the same length—from 500 to 600 feet long—would form a plat of very desirable size. If the work be with a small-eared corn it will be necessary to have the rows shorter. A very small breeding plat should not be used. The results of the yields are not so trustworthy, and in planting but a few ears there is less chance of finding one possessing especially high producing power.

PLANTING THE BREEDING PLAT.

It is better to drill the corn in the breeding plat rather than to plant it in hills. If planted in hills it is impossible in some cases to distinguish suckers from the main stalks. The grower should use the utmost care to get a uniform stand of stalks in all the rows. The fertility of the soil and the available moisture will decide how thick the stand of stalks should be,[a] but it should be the same as for other cornfields planted on similar soil. For convenience in labeling the seed selected from the various rows, it is best to number the rows by means of stakes at one end.

Border rows.—In order that all the rows may be similarly situated, a few border rows should be planted entirely around the breeding plat. Such border rows will often protect the breeding rows from depredations of crows, squirrels, chinch bugs, etc.

The seed used in planting the border rows should of course be from very select ears. Usually enough is left of the ears used in planting the breeding rows to plant the border rows.

The breeding plat should be given the same good cultivation that other cornfields require.

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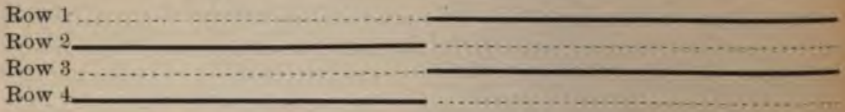
[a] See Farmers' Bulletin 199, U. S. Department of Agriculture, p. 24.

DETASSELING TO PREVENT SELF-POLLINATION.

Before the corn comes into tassel, or even earlier, a few rows may exhibit marked weakness. Such rows should have the tassels pulled from all the stalks as soon as the tassels show plainly in the top of the stalks and before pollen is discharged. In the same manner the tassels should be pulled from all the undesirable stalks in all the rows. Undesirable stalks consist of barren stalks, stalks with many suckers, feeble or very slender stalks, smutty stalks, etc. If detasseled in time the transmission of these characters to the next generation will be prevented.

In order that seed may be selected that has to no extent been self-pollinated, one-half of each row is detasseled. That this may not interfere with proper pollination, it is performed as here illustrated:



Each row is detasseled from one end to the middle, alternating ends of adjoining rows being detasseled.

Figure 8 illustrates the yields of ears from two adjoining rows.

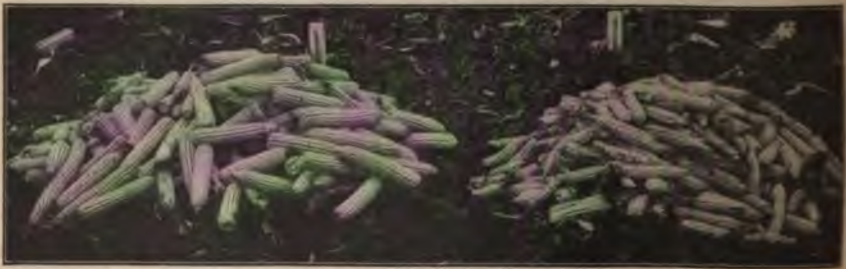


FIG. 8.—Injurious effect of self-pollination shown in pile at right.

The crop on the left was produced by seed from an ear that was hand-pollinated with pollen from another stalk of the same kind of corn; while the crop on the right was produced by seed from an ear that grew on the same stalk as the ear first mentioned, but was hand-pollinated with pollen from the same stalk on which the two ears grew. The difference in the two piles of corn is due to self-fertilization; for all of the many other tests made gave results like those here illustrated. Under ordinary field conditions a portion of the kernels are produced by self-pollination, and there is every reason to believe that those kernels which are the result of self-fertilization are reduced in power of production to the same extent as shown in the illustration. Pulling the tassels from the stalks before they discharge any pollen entirely prevents self-fertilization. In order to do this work thoroughly, the plat will have to be gone over every two or three days at tasseling time.

COUNTING THE STALKS.

After the detasseling is finished there is no work to be done in connection with the breeding plat until the stalks turn brown and the ears begin to dry. An exact count should then be made and recorded of the total number of stalks, including suckers, contained in each row.

SELECTING SEED FROM THE BREEDING PLAT.

When the majority of the stalks are ripe and the husks and ears are fairly dry, the detasseled portion of each row should be gone over separately and the ears from all desirable stalks gathered, weighed, and at once spread out to dry, the row number being kept with each lot of ears. Of course it is only from ten or a dozen of the most productive rows that we wish finally to retain seed for planting; but, as we can not know the most productive rows until the yield from each row is weighed, it is necessary to select seed from all the rows except those that are conspicuously poor or weak. Such rows should be entirely ignored, as should also any rows that have a poor stand of stalks. This is important, because no test of production can be made unless the stand is quite uniform.

When dry enough to harvest, the ears from each row should be gathered and weighed, and the weight of corn from each row added to the weight of the seed ears that were previously gathered from the same row. This addition gives the total number of pounds produced by each row.

DETERMINATION OF THE MOST PRODUCTIVE ROWS.

It is impossible to secure exactly the same number of stalks in all the rows at harvest time, and the row that contains the most stalks will have the advantage unless the stand is too thick to allow of greatest production. Ignoring the rows that fall much below a perfect stand, the others should be ranked according to their average production per stalk, which is obtained by dividing the number of pounds produced by a row by the number of stalks that grow in the row. The secret of a large corn crop lies in having each stalk produce well. By taking seed ears from detasseled stalks that produce well and which grew from ears of high producing power, progress is made each year in increasing the yielding power of the strain.

Having now calculated the average production per stalk of each row in the breeding patch, except the conspicuously poor ones, the best ears from the ten or dozen highest ranking rows are examined, kernels measured, etc., as already outlined (p. 11), and six to ten of the very best ears from each of the highest ranking rows preserved for the next year's breeding plat. A similar number of second-best ears are also preserved, as a safeguard against losing the work of previous years in case hail, floods, or insects should destroy the breeding plat. After the improvement has been continued for a few years it is exceedingly important to save this extra supply of seed.

The work as outlined is repeated each year, and the improvement from year to year is very noticeable and gratifying to the breeder.

THE INCREASE FIELD.

It is not supposed that seed in sufficient quantity for general planting or for sale will be obtained from the rows of the breeding plat. The method has been outlined for the purpose of showing how a highly productive strain is originated. To obtain seed for general planting and for sale, an increase field is grown from the remaining seed obtained from the desirable stalks of the detasseled portion of the highest-ranking rows. Due precaution is taken to prevent the increase plat from being cross-fertilized with inferior strains. Otherwise it is planted and cared for as any other cornfield. It is called the " increase field " because it is used to increase the quantity of well-bred seed produced in the breeding plat. The increase field is not grown for the purpose of improving the strain of corn, but solely for the purpose of increasing the quantity of good seed of the strain improved by the necessarily complex method outlined.

The breeding plat will each succeeding season furnish seed more highly improved for planting the increase field. From the increase field seed is obtained in large quantities for general planting and for sale. For these purposes the good seed ears can by some convenient and rapid process be separated from poor ones. This can be done most handily, perhaps, as the wagonloads of corn from the increase field are being unloaded at the cribs.

IMPORTANCE OF FOLLOWING A METHOD OF CORN IMPROVEMENT.

Corn bred for several years for increased production will produce, with exactly the same treatment, 10, 20, or even 40 bushels more per acre than unselected seed. Counting the increase at but 10 bushels per acre, when corn is selling at 40 cents per bushel well-bred seed bears a money value of $24 per bushel and the profit on the corn crop is increased $4 for every acre grown. This estimation is very conservative, the profit often being four times as great. Corn can be considerably improved and rendered quite uniform by selecting from year to year the best ears from the best stalks, without regard to the producing power of individuals or without employing the aid obtained from detasseling. The improvement, however, in such case is not so rapid. Some think it necessary to obtain new seed every few years, claiming that their corn has "run out." A good strain of corn, like a good breed of animals, will "run out" if pains are not taken to propagate from the best individuals. Instead of allowing a strain of corn, through neglect, to "run out," it can be "run up" in producing power by some such system as has been outlined.

CARE OF SEED CORN.

The next step in importance after the growing of good seed corn is its care from the time it is gathered until it is planted. It is advisable that all corn which is to be used as seed—for the breeding plat, for general planting, or for sale—should be preserved in the best manner possible. Good care consists in carefully drying the ears, and at the same time seeing that they dry quite rapidly. This should be done as soon as they are gathered, and they should then be stored in a dry place of even temperature and where they will not be reached by damp air. Seed corn, although it may have become very dry, will absorb moisture if it comes in contact with a damp atmosphere. When first gathered, seed corn often contains 20 to 25 per cent of moisture, and may be greatly injured in one day's time if allowed to freeze or to heat.

One of the most satisfactory ways of drying seed corn is to place it in thin layers on a series of floors made of narrow strips of board laid just close enough together to keep the ears from falling through. These floors should be in a shed or building that can be well ventilated, and preferably one which can be closed during damp weather.

In northern sections, where freezing weather comes as soon as the corn has matured, or even before, artificial heat is needed to keep the corn from freezing; but the heat should be used in connection with an abundance of dry air, as corn is not dried by heating, unless a means is provided for the moist air to pass out.

In southern sections, usually no trouble is encountered in drying seed corn, but it often becomes necessary to treat it in order to prevent its destruction by weevils, grain and flour beetles, and the Angoumois grain moth. For this purpose the Bureau of Entomology advises the use of bisulphid of carbon at the rate of 1 pound of the insecticide to 100 bushels of grain. The fumigation is made in a bin or a specially prepared box or other receptacle made as air-tight as possible. The bisulphid is allowed to evaporate from plates or dishes, and the exposure lasts from twenty-four to forty-eight hours. The corn should not be fumigated until dry, as it is likely to heat. Full directions for the use of bisulphid of carbon as a remedy for weevils in stored grain are given in Farmers' Bulletin No. 45, which may be obtained by application to the Secretary of Agriculture. The use of bisulphid of carbon is further discussed in detail in Farmers' Bulletin No. 145. The bisulphid is very inflammable and even explosive when mixed with air under certain conditions, and must therefore be handled with great caution. Before using it, read the bulletins referred to carefully.

The seed of the corn plant is produced for the purpose of perpetuating the species, and Nature does her work so well that practically every kernel that matures will grow. If, however, the seed be exposed to unfavorable conditions, its power to grow will be reduced or destroyed. It therefore becomes a matter of much more importance to preserve the vitality of seed corn than to attempt to separate by germination tests the poorest ears from poorly preserved seed. The fact that some ears have lost their vitality indicates that the vitality of other ears in the same lot of seed has been more or less injured.

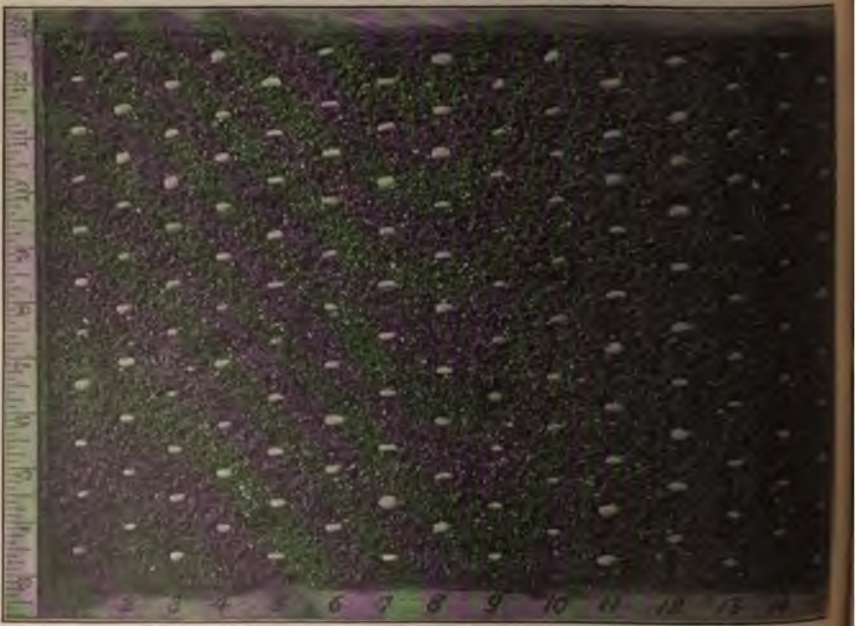


FIG. 9.—Means of testing the germinating power of individual ears.

Prevention is better than cure, even were a cure possible, which is not the case. The writer has yet to find an instance in which seed corn has not germinated satisfactorily when it has matured properly and received proper care from the time of maturity until tested the following spring. Unfavorable field conditions at planting time or soon after may cause seed of perfect germinating power to result in a poor stand.

ery early freezes that frequently occur in the Northern States orn is fully ripe make it necessary that prompt attention be seed-corn selection in the North.

TESTING THE GERMINATION OF SEED CORN.

orn should be so well cared for that it will contain no ears l not germinate, and seed testing should be employed as a ation of the fact that the seed has received proper attention, an as a screen to separate the worthless from the poorly pre- ed. If through accident or carelessness a supply of seed has amaged that a test of 100 or more representative ears proves

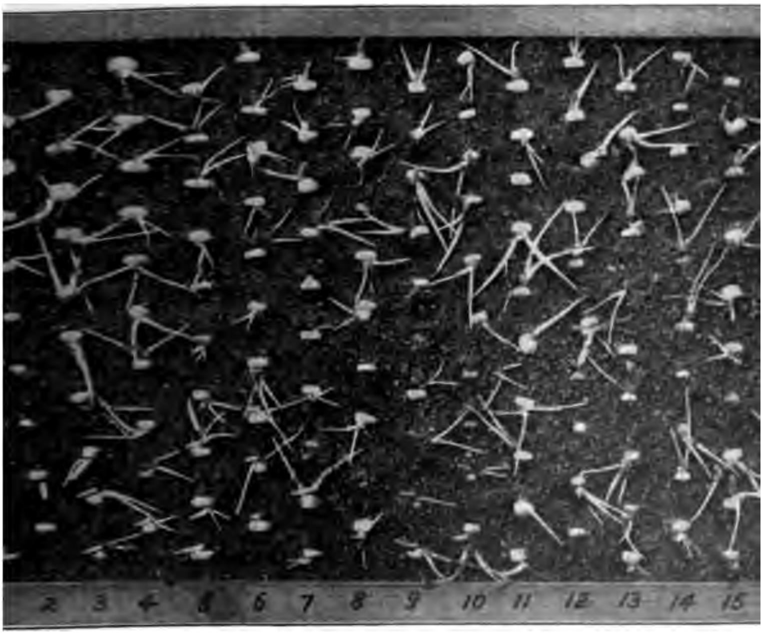


Fig. 10.—Same kernels as shown in Fig. 9, photographed five days later.

ess than 97 kernels out of every 100 germinate, and better seed ot be procured, it is certainly advisable to test the ears sepa- and discard the poorest.

is test can very easily be made by numbering the ears and then g 5 (or 10) kernels from each ear and placing them in num- rows in shallow boxes of moist sand, arranging them so that the ls from ear No. 1 are in row No. 1, etc. Figure 9 shows a por- f such a box photographed just after 10 kernels from each ear placed in the rows, and figure 10 the same rows five days later. e boxes used are 2 or 2½ inches deep and a damp cloth is spread the top after the kernels are placed in the sand, no further attention will be necessary for five or six days, when the results of the test can be recorded. The box should be kept in a warm place where the temperature does not fall lower than 50° F.

CONCLUSIONS.

There is a general demand for well-bred seed corn.

Every geographic section of the United States where the soil or climatic conditions are distinctive needs one or more careful corn breeders.

Until the merits of a strain of corn and the honesty of the one who sells it are known, farmers should purchase sparingly and insist on receiving the seed as ear corn.

The most important character a corn can possess is ability to produce large yields. This important character can be greatly increased by persistent selection of good seed ears from the progeny of ears that have proved most productive.

Properly conducted corn-breeding work will prove highly profitable to the breeder and to the purchasers of the seed corn.

Vitality is preserved by thoroughly and quite rapidly drying the seed ears and storing them where they will not be exposed to damp atmospheres or sudden changes in temperature.

If found necessary to plant seed the vitality of which is at all doubtful, test each ear separately and plant only those which germinate perfectly.

APPENDIX.

SELECTION AND CARE OF SEED CORN.

By H. J. WEBBER,
Physiologist in Charge of Laboratory of Plant Breeding.

Some farmers may not have the time to breed their seed corn or opportunity to purchase, as outlined in the foregoing paper. The crop depends largely on the seed, however, and no farmer can afford to neglect to save and select his seed corn by some careful method. Those who can not breed their own seed corn or buy carefully bred seed of suitable kind are urged to follow the best methods of selecting seed from their field crop, and to give the selected seed the best of care. The suggestions which follow may prove helpful in this work. They will also prove especially useful to the farmers who have purchased improved seed, and who wish to maintain the productiveness of the strain without purchasing new supplies of seed every year.

When to harvest seed corn.—It is important that the seed corn be thoroughly dried out before it is subjected to severe freezing. It is desirable to select the seed corn early in the fall, before there is danger of freezes. Light frosts would not injure the seed, but the selection should not be delayed too long, as a severe freeze might greatly injure the vitality of the seed if it was not thoroughly dried out when the freeze came.

Where to gather seed.—Select your seed from that portion of the field which is uniformly the best developed. It is a good practice to husk this portion of the field early in the season to be sure that those ears saved for seed will have been husked and preserved before freezes occur.

How to harvest seed in field.—Have a seed box attached to the wagon box, if the corn is husked in the field standing, and whenever an especially good ear is found throw it in the seed box. Don't be afraid of getting too many good ears, as they should be examined more carefully later and only the very best of them selected for planting. From two to three times as much seed should be selected at this time as will be necessary to plant the next year’

How to harvest seed from shock.—If the corn is cut and shocked, that portion of the field from which seed corn is to be selected should be husked before freezes occur and the best ears selected and kept separate as in the preceding case.

How to preserve seed.—The seed corn selected as above indicated should be placed in a dry, well-ventilated room where the ears can be spread out. They should not be piled in a heap, as it is important to expose them to a free circulation of air, so that they will dry quickly and thoroughly without molding. It is a good practice, often followed, to leave a few husks attached to each ear, so that the ears may be tied together in pairs by means of the husks and then hung over poles or wires in the upper part of the room. If convenient, racks can be made like bookcases, with slat shelves about 4 or 5 inches apart, and open backs and fronts, in which the ears can be arranged until thoroughly dried. Only one row of ears should be placed on each shelf. This method allows the preservation of a large amount of seed corn in a small space.

Use of artificial heat in drying seed.—It has been found to be very important to dry out the seed corn quickly and thoroughly, and the use of some artificial heat is in most cases desirable. It is thus important, especially in damp, cold seasons, to place the seed corn in a room where there is a stove in which a fire can be maintained at least a portion of each day for about two weeks, or until the corn is thoroughly dried out. In favorable dry autumns artificial heat may not be necessary, but in many cases the "kiln drying" of seed, as it is called, will be found to be very important. In one experiment made by Mr. Hartley on the Department's experimental farms kiln-dried seed gave an average yield of 16 bushels per acre more than ordinary air-dried seed of the same variety grown in the same place. The experimental field in this case contained about 10 acres, and was planted with the air-dried and kiln-dried seed in alternate rows.

Selection of seed ears.—After the corn is thoroughly dried out, preferably some time in the winter, when farm work is not crowding, all the ears should be examined carefully, and a sufficient number of the very best and largest ears should be selected to plant the next year's crop. In making this selection the grower should carefully examine each ear, selecting those having deep and well-formed kernels, which will give the greatest weight of shelled corn per ear (see pp. 10 and 11). The imperfect kernels at the tips and butts of these selected ears should be shelled off and discarded before the ears are finally shelled for planting.

Testing the germination.—Test the germination and comparative vigor of growth of these seed ears, as already described (p. 19). If any of the ears give poor or slow germination or lack vigor, discard such ears.

Grading the seed corn to fit dropping plates.—A perfect stand is one of the principal factors in securing a good yield. If 3 or 4 stalks per hill is a perfect stand, hills with 1 or 2 or with 5 or 6 stalks will make a poor stand and give a loss in yield. It is important to have good seed of perfect germination, and to have the seed grains dropped uniformly, with the right number in the hill. It is thus desirable, as emphasized by Prof. P. G. Holden, of the Iowa Agricultural College, to separate the seed ears selected into three classes, or grades, having (1) small, (2) intermediate, and (3) large kernels, and shell and preserve these three grades of seed separately. Before beginning the planting, the planter can be carefully tested with each grade of seed, and the dropping plates with different-sized holes or marginal notches selected for each grade, which by careful trial are found to uniformly drop the desired number of kernels. These plates, after thorough test, can be marked, and used when needed with the proper size of seed grains without loss of time in the rush of planting.

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The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 230.

AME LAWS FOR 1905.

A SUMMARY OF THE PROVISIONS RELATING TO SEASONS, SHIPMENT, SALE, AND LICENSES.

BY

T. S. PALMER, HENRY OLDYS, and R. W. WILLIAMS, Jr.,
Assistants, Biological Survey.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., September 7, 1905.

Sir: I have the honor to transmit herewith for publication in the series of Farmers' Bulletins a summary of the game laws for 1905 relating to seasons, shipment, sale, and licenses, prepared by T. S. Palmer, Henry Oldys, and R. W. Williams, jr., of the Biological Survey. This bulletin is similar in scope to those issued in 1902, 1903, and 1904 and includes the changes in the laws made during the present year. The information presented is much more condensed than in previous bulletins, but is arranged in such form as to be useful to those who are interested in game protection.

Respectfully,

A. K. Fisher,
Acting Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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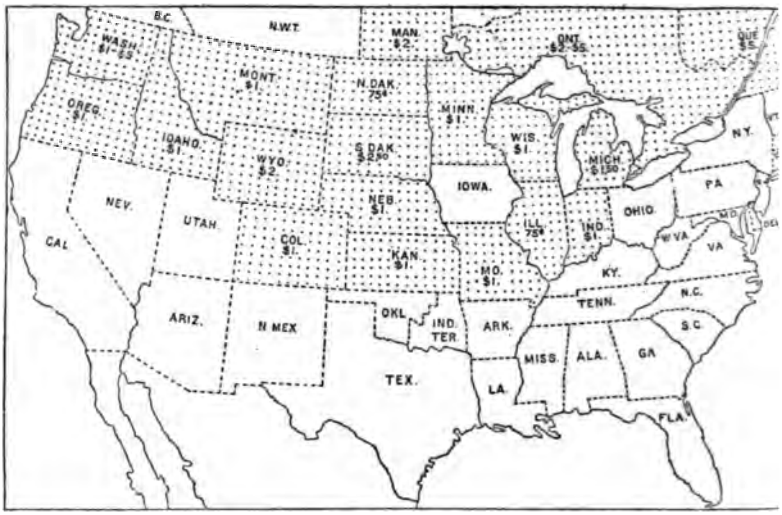

Fig. 1. States and Provinces which require residents to obtain hunting licenses.

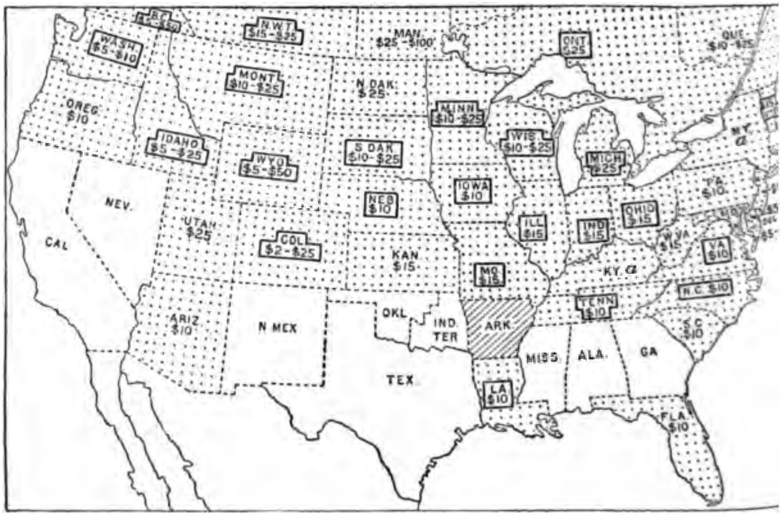

Fig. 2. States and Provinces which require nonresidents to obtain hunting licenses.

Inclosed names indicate that special privileges are granted for taking a limited amount out of the State. States marked *a* have no definite fee. Arkansas **does not permit hunting** residents, Massachusetts requires unnaturalized foreign-born **residents to secure licenses at** Washington issues nonresident alien licenses at $50. (For details see pp. 40–48.)

Maps Showing License Laws.

GAME LAWS FOR 1905.

INTRODUCTION.

SCOPE OF THE BULLETIN.

The object of the present bulletin is to present in convenient form summary of the game laws of the United States and Canada that overn seasons, shipment, sale, and licenses. Its purpose is, pri-arily, to furnish information concerning restrictions on trade in ame, knowledge of which is important in connection with the nforcement of the Lacey Act. Hence such provisions as relate to ethods of capture of game, enforcement of laws, disposition of fines nd fees, and such matters as are of special or local application are ot included. These may be found elsewhere, either in summaries repared for the use of sportsmen by game associations, railroad com-anies, and private publishers, or from the laws themselves, which in ost cases may be had in separate form from game commissioners or ecretaries of state.[a]

The demand for a publication containing a concise summary of exist-ng game laws, both national and State, apparently increases in direct roportion with interest in game protection, and the need of such a ummary constantly grows with the increasing complexity of game egislation and the tendency in some quarters to permit county boards of supervisors to fix hunting seasons or modify those established by legislative action. In Alabama, Maryland, and North Carolina the legislatures enact separate laws for the different counties; in New York, Oregon, and Washington laws for different districts or sections of the State are fairly numerous, and becoming more so; in Mississippi, county boards of supervisors have full authority to regulate hunting; and in Louisiana, Nevada, and Virginia, county officers are empowered to shorten or shift open seasons. In the following tables such local laws and regulations are included as fully as possible, but as some are inaccessible and others are likely to be changed at any time, a complete and accurate summary of them is impracticable.

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[a] A directory of these officers with their addresses and a list of the commissions hich issue fish and game laws in separate form may be found in [illegible] No. 50 o' he Biological Survey, U. S. Department of Agriculture, [illegible]

LEGISLATION OF 1905.

In 1905 legislative sessions were held in 41 States and Territories, and in all but 2 of these changes were made in the game laws. Including the local laws of New York and North Carolina, the statutes affecting game numbered about 180, exclusive of appropriation bills. In the following résumé the acts of Vermont are included, as the session of its legislature in 1904 occurred in the autumn too late to incorporate the changes in the game law bulletin of last year. Seven States—Arizona, Idaho, Indiana, Minnesota, Missouri, Kansas, and Utah—adopted entire new game laws, and California, Michigan, Missouri, and South Carolina passed laws giving complete protection to nongame birds. Important progress in protecting game birds was made in a number of States, among which should be mentioned Montana, Utah, and Wisconsin, which cut off spring shooting of waterfowl, and California, Colorado, Indiana, Pennsylvania, and Utah, which gave protection to shore birds. More attention than usual was paid to licenses, and a strong tendency was noticeable toward local legislation, which, in North Carolina, was carried to the extreme of enacting special laws for a number of different townships.

Among the novel features of the legislation of the year may be mentioned the adoption by Montana of a uniform season for all game, thus greatly simplifying the law; the principle adopted by Oregon and Vermont of fixing certain seasons by days of the week instead of the month; the practical prohibition by Minnesota of placing game in cold storage; the establishment by Wyoming of a large State game preserve immediately south of the Yellowstone Park; the adoption by Wyoming of a $1 permit for photographing big game in winter; and the requirement of Wisconsin that each special deputy warden shall carry an identification card bearing his photograph, his signature, the seal of the department, and a miniature reproduction of his commission.

Licenses.—Several States enacted some form of license legislation for the first time. Arizona, Kansas, Missouri, Oregon, and Vermont adopted nonresident licenses; Kansas, Missouri, Montana, Oregon, and Manitoba resident licenses, and Massachusetts, Utah, Washington, Wyoming, and Manitoba, alien licenses. In Manitoba persons who are not British subjects are now required to pay a license fee of $100. Florida made its nonresident-license requirement applicable to all noncitizens of the State; Indiana established a resident license for all game throughout the season instead of ducks in the autumn; South Carolina reestablished, in a modified form, its market-hunting license for ducks and its nonresident county license; and Illinois extended its resident license to cover rabbits; Maine, Montana, Minnesota, and New

Hampshire extended their big-game licenses to cover all game, and Nova Scotia consolidated its moose and bird licenses into one $30 license for all game. Maine established a $5 license for hunting prior to October 1, and Michigan a $10 export license for ducks shipped by nonresident land owners and members of clubs maintaining preserves in the State. Several changes were made in the fees. Tennessee adopted a $10 license (except in about 30 counties) in place of its former variable fee; Washington replaced its $1 county license by a $1 license for residents, a $5 license for nonresidents, and a $50 license for aliens, and provided corresponding State licenses of $5, $10, and $50; Michigan increased the resident license fee for big game from 75 cents to $1.50, South Dakota from $1 to $2.50, Wyoming from $1 to $2, and New Brunswick raised its nonresident license from $30 to $50. Reductions in the fees were made in the resident license of Illinois from $1 to 75 cents; in the small-game nonresident license of Montana from $15 to $10; in the nonresident license of Indiana from $25 to $15; and in that of Nova Scotia from $40 to $30, with repeal of special licenses. Montana abolished the exemption of taxpayers from the nonresident requirement, made the resident license good for a family, and provided for its issue to United States soldiers stationed in the State. Wyoming placed United States soldiers on the same footing as residents, and removed the exemption which permitted residents to hunt in their own counties without license. Hawaii abolished the $5 hunting license which has been in force in Oahu since 1896.

Shipment.—A few important changes were made in the laws regulating the export of game. Missouri and British Columbia extended their nonexport laws to cover all protected game. Maine, which formerly prohibited export of wood ducks, black ducks, teal, and gray ducks, changed its law so as to include practically all ducks. Utah added shore birds to its prohibited list; New Hampshire, birds, and Arizona, ducks. On the other hand, Wyoming modified its prohibition of the export of any big game except under a hunting license, so as to permit the shipment of 1 head, 1 hide, 1 scalp, and 1 pair of tusks of any big game except moose, by any person under certain restrictions. Michigan authorized the export of 1 deer under the nonresident license, and ducks by nonresidents under the special license mentioned above. Missouri in its new general law provided for the export of a limited amount of game by nonresident licensees, and Washington extended this privilege to all nonresident licensees instead of restricting it to those from Oregon; South Dakota reduced the export limit on deer from 2 to 1; New Hampshire cut off all export of deer, and Manitoba made it necessary for a nonresident to secure an export permit from the minister of agriculture and immigration.

Propagation.—Several changes of more or less importance were made for the purpose of encouraging the propagation of game. Minnesota passed a law permitting the breeding and domestication of big game under permit from the commissioners, with a fee of 50 cents for each animal held in captivity. Michigan provided for limited and Washington for unlimited capture of birds and animals for propagation. Missouri authorized the State warden to issue permits for the possession or export of game or birds for scientific or propagating purposes, and also to secure and transmit to other game officials fish or game for these purposes. Tennessee likewise authorized the State warden to capture or transfer game for propagation, and also to import game birds or their eggs for distribution. Utah added three counties to the two that already allowed export of quail for propagation from the county. Pennsylvania provided for propagation of game under certificate and with bond and fee requirements; and Wyoming replaced the law permitting residents to take big game on their own premises for domestication, scientific or breeding purposes, with one authorizing the capture of a limited number of young of deer, elk, mountain sheep, and antelope for domestication and propagation, under the authority and supervision of the State game warden, on payment of a fee of $1.

Sale.—Missouri and Manitoba extended their lists of game that can not be sold to cover all protected game. Manitoba formerly permitted the sale only of ducks, but Missouri allowed the sale of all game but deer and upland birds killed in the State. Several States extended their lists of game the sale of which is prohibited. Idaho placed birds on the list; Kansas, red squirrels, plover, ducks, geese, and brant; Maine, practically all ducks; Massachusetts, deer taken in the State; New Mexico, doves and pigeons; Pennsylvania, woodcock and wild turkeys; Utah, quail; Wyoming, heads of big game; California, doves and shore birds; and Manitoba the heads of all big game (formerly only those of mountain sheep), the female and young of elk and caribou, blue grouse, swans, and ducks. On the other hand, a few States reduced their lists. Washington removed from the list hides of big game; Minnesota, hides of deer, moose, and caribou taken outside the State. Wyoming provided that 1 hide, 1 scalp, 1 head, and 1 pair of tusks of big game may be sold under a 25-cent permit from the State warden. Pennsylvania fixed a season for the sale of imported ruffed grouse and Illinois removed the restriction confining the sale of imported game during a limited season to cities, towns, and villages.

Warden service.—The game warden system was installed for the first time in Kansas, South Carolina (county wardens only), and British lumbia. An assistant warden was added in Manitoba; and in New inswick a chief ranger to supervise enforcement of laws of the st and to guard against forest fires. The number of wardens was eased in Illinois and Ontario, and California made more liberal ision than heretofore for its warden service. Vermont, following

New York, placed its service under a single commissioner. Wyoming provided for arrest and seizure without warrant, and Minnesota and Missouri conferred the power of search on their game officials.

Following are the principal changes in the laws; those marked with an asterisk (*) are based on recommendations of State officers:[a]

Arizona.—One general act establishing a $10 nonresident license* and bag limits on quail and deer; giving absolute protection to antelope and introduced pheasants until 1911; extending the open seasons for deer and turkeys a month in each case; and prohibiting the export of ducks.

Arkansas.—(Laws not received.)

California.—Six acts: Protecting nongame birds and defining game birds; adding shore birds to the list of protected game birds; shortening the open season for deer; giving tree squirrels and swans* absolute protection; prohibiting the sale of doves and shore birds;* reducing the number of deer which may be killed in a season from 3 to 2; and the number of doves which may be killed in a day from 50 to 25;* placing a bag limit on shore birds and increasing that on rail from 20 to 25; making more liberal provision for the warden service;* and protecting gulls and cranes.

Colorado.—One act making slight changes in seasons for deer, sage chickens, and doves; and adding shore birds to the list of protected game.

Connecticut.—Five acts: Shortening the open season for rabbits one month, thus making a uniform season for upland game; providing for payment of damages for injuries to crops by deer; increasing the penalty for killing deer from $100 to $500; extending prohibition of using ferrets in hunting rabbits until October 1, 1909; and fixing a two months' open season for introduced pheasants.

Delaware.—Two acts: Changing the opening date of the season for reed birds to September 1, to conform with that in adjoining States; and protecting all squirrels except red squirrels.

Florida.—Two acts: One reenacting the law providing for county wardens; the other reducing bag limits, and requiring all persons not citizens of the State to secure nonresident licenses.

Georgia.—An act changing the seasons for doves, snipe, and marsh hens.

Hawaii.—An act repealing the law of 1896 requiring hunting licenses in Oahu.

Idaho.—A new general law giving absolute protection to antelope; shortening the season for wild fowl; changing the open season for doves, snipe, and plover from spring to fall; prohibiting the sale of birds; and changing the hunting licenses to a $25 nonresident license for big game only, and a $5 license for birds.

Illinois.—One act requiring resident licenses for hunting rabbits as well as other game,* and reducing the fee from $1 to 75 cents;* authorizing the use of the surplus in the State game fund for stocking the State with quail, prairie chickens, and pheasants,* and for exterminating crows and hawks; reducing the bag limit on ducks from 50 to 35; extending the close season on ruffed grouse and prairie chickens until 1909; allowing the sale of imported game throughout the State between October 1 and February 1,* and increasing the number of wardens in each county from one to three.*

Indiana.—Two acts: One establishing a new close season of six years for imported pheasants, the other comprising practically a new game law which establishes a fall season for rabbits, allows an open season for doves, virtually removes protection from woodcock, establishes a general resident hunting license, and reduces the nonresident license fee from $25 to $15.

Kansas.—Three acts: A special law continuing the close season for quail and prairie chickens for three years in 19 counties; a general law establishing the office of State game and fish warden; providing for $15 nonresident and $1 resident, licenses;

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[a] See "Recommendations of State Game Commissioners and [illegible] 47, Biological Survey, U. S. Department of Agriculture, 1905.

placing a bag limit on birds; making various changes in close seasons; and prohibiting the sale of red squirrels, plover, ducks, geese, and brant; and a local law applicable to Rawlins County only permitting owners of land, their guests, and tenants to hunt quail and prairie chickens on such land for a limited time after the close of the season.

Maine.—Five general acts: Extending the close time on caribou six years; changing the $15 nonresident license so as to make it apply to all game after October 1 and establishing a $5 nonresident license for hunting prior to that date; * extending the deerskin license to include skins of all animals lawfully taken; giving special protection to eagles and vultures, and extending the protection accorded wild fowl to cover practically all ducks. Also five local acts making changes in close seasons or imposing additional restrictions.

Massachusetts.—Eight acts: Establishing a $15 hunting license for unnaturalized foreign-born residents of the State; * giving absolute protection to upland plover until 1910; * extending the close season on imported pheasants until 1907 and that on quail on Nantucket Island until 1908; shortening the open season on quail elsewhere in the State to the month of November; providing for sale and possession of live quail for propagation at any time under permit from the commissioners of fisheries and game; placing certain restrictions on the killing of dogs chasing deer; and giving added protection to ducks in Dukes County.

Michigan.—One general act extending absolute protection of elk, moose, and caribou until 1913, and deer (in certain counties) to 1908; closing the season on quail until 1907; * establishing a bag limit on birds; restricting the training of dogs in close season; defining game birds and giving comprehensive protection to nongame birds; allowing limited collection of birds and animals for scientific or propagating purposes; increasing the resident license fee from 75 cents to $1.50; allowing nonresident licensee to export one deer; and establishing a limited $10 export license for ducks.

Minnesota.—One general act, embodying the following new features: Prohibition of cold storage of game and authorization of game wardens to search for stored game; reduction of number of deer allowed each resident to 2 * and each nonresident to 1, and bag limit on birds * to 15 a day; nonresident permitted to export deer, but not moose; and absolute protection given to caribou until 1913.

Missouri.—One general game law of 71 sections, declaring game and birds to be the property of the State; giving protection to nearly all nongame birds; providing for an efficient game-warden service; establishing resident and nonresident licenses with fees of $1 and $15, respectively; prohibiting sale and export of game, except export of a limited amount under the nonresident license; fixing bag limits of 1 deer, 2 turkeys, and 25 other birds a day, with allowance of 2 deer, 4 turkeys, and 50 birds in possession at one time.

Montana.—Two acts: One making a uniform season for all game; * allowing an open season for mountain sheep and female elk; establishing a bag limit on mountain sheep, and reducing the bag limits on deer,* elk, mountain goat, * and upland game birds; the other establishing a $1 license for residents and United States soldiers; extending the $25 nonresident license to cover all game, instead of big game only; reducing the fee of the nonresident bird license from $15 to $10; withdrawing the privilege formerly allowed taxpayers of hunting without procuring nonresident licenses; classifying cooks and packers as guides; and establishing a 50-cent license for a limited export of game.

Nebraska.—An act giving absolute protection to squirrels, formerly unprotected, and limiting the bag of prairie chickens to 10 a day in September * (but retaining the bag of 25 a day during the rest of the open season).

Nevada.—One act giving special protection to the American eagle.

New Hampshire.—Four acts: Protecting loons absolutely; shortening the open season for quail, grouse, woodcock, and snipe; prohibiting the use of swivel and punt guns; extending the nonresident deer license to cover all game, and prohibiting all export of deer, but permitting holders of nonresident licenses to export 12 birds.

New Jersey.—One act further regulating wild-fowl shooting.

New Mexico.—One act shortening the deer season;* according absolute protection to antelope, bobwhite, and wild pigeons until 1910, and to elk,* mountain sheep,* and ptarmigan indefinitely; and placing turtle doves on the game list.*

New York.—Sixteen acts: Making changes in a few counties in the seasons for deer, squirrels, rabbits, quail, grouse, and woodcock; prohibiting capture or sale of land turtles or tortoises; relieving game protectors of their duties as fire wardens and in connection with the protection of forest preserves and public parks; and amending sections 409 and 410 of the Penal Code governing the sale of weapons so as to prohibit sale or gift of firearms, air guns, or spring guns to persons under 16 years of age, and to prohibit persons not citizens of the United States from carrying firearms in public places at any time.

North Carolina.—Sixty-seven acts: The most important ones prohibit export of quail from four counties, Catawba, Madison, Surrey, and Swain; sale of quail in Catawba, Forsyth, and Iredell counties; sale of quail, duck, and wild turkey in New Hanover County, and all game in Randolph County; abolish the $20 nonresident license and remove the export prohibition in Cabarrus County; abolish the $50 market-hunting license and establish a bag limit in Brunswick County; prohibit hunting on the lands of another without permission in Currituck, Hertford, Madison, Wayne, and Yadkin, and parts of Anson, Martin, Randolph, Rutherford, and Robeson counties; and repeal the requirement of permission in Cabarrus and Henderson counties.

Oklahoma.—No regular game law was passed, but the school law contains a provision requiring instruction at least half an hour each week concerning the habits of animals and birds, and their protection. (Ch. 33, art. 12, sec. 2.)

Oregon.—Six acts: Establishing a $10 nonresident* and $1 resident license; abolishing the open season on prairie chickens until 1909; extending protection to all ducks, shortening their open season and reducing the bag limit* on them; prohibiting practically all sale of game; omitting protection of moose, antelope, mountain sheep, also of deer in four counties; and east of the Cascades, opening the season for a few days on quail under a small bag limit, and protecting geese at all times on the Columbia River.

Pennsylvania.—Three acts: One providing for the appointment of special deputy game protectors to serve without compensation; another empowering the board of game commissioners to establish preserves for deer and upland game birds; and a general game law defining game and providing comprehensive protection for nongame birds; empowering the board of game commissioners to destroy wild birds and animals destructive to game; restricting the collection of birds and nests for scientific uses;* exempting public zoological parks and museums from the game laws; providing for propagation of game under certificate with fee and bond; altering close seasons for game; protecting bears from March 1-October 1; fixing bag limits by day, week, and season; restricting deer hunting;* prohibiting hunting certain game for hire, and all sale of wild turkey or woodcock; and permitting persons charged with violating the game laws to pay penalty and costs to a game protector in satisfaction of offense charged.

Rhode Island.—Three acts: Opening a two-months' season on quail, grouse, and woodcock; continuing the prohibition of the sale of these birds indefinitely;* extending the absolute protection of introduced pheasants and prohibition of their sale to 1910,* and shortening the open season for gray squirrels, rabbits, and hares.

South Carolina.—Five acts: Establishing a $50 resident county license for market hunting of ducks and a $10 nonresident county license for general hunting; providing for confiscation of paraphernalia used in violation of law; for the appointment of a game warden, with limited powers, for each county, and for the protection of nongame birds.

South Dakota.—One act shifting the open season for big game to begin November 1 instead of November 15; reducing the bag limit on deer from 3 to 2; increasing the resident hunting-license fee for big game from $1 to $2.50; increasing the salary of big-game wardens from $50 to $75 a month; and limiting their appointment to counties in which big game is found, but giving them jurisdiction throughout the State.

Tennessee.—Two general acts: One establishing a new warden system (except in 38 counties mainly in the middle of the State); the other (not applicable to 32 counties) protecting deer and introduced pheasants absolutely for two years; extending the open season in spring on dove, teal, and wood duck; providing a $10 fee for the nonresident hunting license, to replace the former indefinite fee; establishing graded licenses of $5, $10, and $25 for dealers in game; establishing bag limits on game birds; and authorizing the State warden to import or take game birds or eggs for propagation or distribution. Seven county acts were also passed, requiring nonresidents to secure written consent of landowners before hunting or fishing in 4 counties; abolishing close seasons on squirrels in 16 counties, and fixing close seasons on squirrels in 11 others; altering the seasons for wild turkeys in 2 counties; and providing special laws for Hardeman and Warren counties.

Texas.—Two acts: One placing a bag limit on squirrels of 10 a day, and a sale limit of 5 a week, except in 12 senatorial districts; the other exempting certain additional counties from the operation of the law prohibiting hunting upon posted lands.

Utah.—A new general game law giving absolute protection to all big game indefinitely or for a term of years; placing shore birds on the game list and prohibiting their export; cutting off spring shooting of ducks;* placing bag limits on ducks and shore birds and reducing those on upland game; and extending the nonresident requirement to include all persons who are not citizens of the United States.

Vermont.—Six acts: Establishing a $15 nonresident deer license with the privilege of exporting one deer; repealing the law allowing the killing of dogs running deer; establishing bag limits on ducks and ruffed grouse; protecting English partridges until 1909; limiting the open season for deer to the last six consecutive working days in October; and placing the duties of the fish and game commission in the hands of a single commissioner.

Washington.—Three acts: Providing for the creation of game preserves on islands by county commissioners, and giving absolute protection to deer on all islands, and to waterfowl on the Columbia and Snake rivers in most of the counties east of the Cascades; protecting elk absolutely until 1915; prohibiting the use of blinds in hunting waterfowl; replacing the general $1 hunting license by $10 State and $5 county licenses for nonresidents, $5 and $1 licenses respectively for residents, and a $50 license for aliens, with increased export privileges for nonresidents; creating the office of chief deputy warden;* providing for the appointment of salaried county wardens by county commissioners and unsalaried special wardens by county wardens; repealing the prohibition of the sale of hides of big game; opening a season for male pheasants west of the Cascades; and allowing the spring shooting of geese and brant.

Wisconsin.—Several acts: Extending the absolute protection of quail and introduced pheasants to 1910; closing the season on prairie chickens in certain counties until September 1, 1910; fixing bag limits on a number of birds; prohibiting the use of ferrets in hunting rabbits in certain counties; and requiring each special deputy game warden to carry and exhibit on demand an identification card containing his photograph and signature, the seal of the game-warden department, and a miniature reproduction of his commission.

Wyoming.—Two acts: One creating a State game preserve south of the Yellowstone

National Park; the other requiring a $50 general license and a $5 bird license of those who are not electors of the State, and a $2 big-game license * of electors;[a] establishing a bag limit of 12 birds a day; providing for propagation and domestication of big game under license; * authorizing arrest and seizure without warrant; and requiring a $1 permit for photographing big game in January, February, March, and April.

British Columbia.—One act establishing the office of game and forest warden; adding snipe, ptarmigan, and Hungarian partridges to the game list; giving absolute protection to swans (formerly unprotected); prohibiting cold storage of game and the purchase or sale of heads of elk, moose, or caribou, or of elk teeth; decreasing the bag limit on deer from 10 to 5; establishing a $5 nonresident bird license good for one week; limiting the exemption of miners from the game law to those engaged in placer mining in unorganized districts, exempting surveying and engineering parties, and authorizing the lieutenant-governor in council to exempt Indians in the northern part of the Province and those dealing with them, and to declare local close seasons for game or birds.

Manitoba.—One act reducing the open season for big game from 30 to 15 days and the bag limit from 2 to 1; curtailing the open season for ducks, to begin 15 days later than before; establishing a $2 big game license for residents and a $100 nonresident alien license, and repealing the law allowing the domestication of wild animals under permit from the minister of agriculture.

New Brunswick.—One act opening a season for partridges; giving absolute protection to female caribou; requiring the use of tags in exporting heads of moose and caribou; increasing the license fees of nonresidents from $30 to $50 and extending the license to cover deer; requiring nonresidents entering forests and wild lands to be in charge of registered guides; prohibiting guides from securing hunting licenses and increasing their license fees from $1 to $2; creating the office of chief ranger, to supervise enforcement of laws against fires and illegal hunting on wild lands; and providing for the examination of wardens.

Nova Scotia.—One act extending the absolute protection of deer and caribou to 1910; shortening the open season for moose, and lengthening that for rabbits and hares; replacing the special moose and bird licenses by a general license, and reducing the fee from $40 to $30.

Ontario.—One act making a slight change in the close season for hares; extending the absolute protection of introduced pheasants, and prohibition of sale of quail, partridge, woodcock, and snipe to 1910; restricting transportation of big game and trade in their hides; and increasing the number of game wardens from 4 to 7.

CLOSE SEASONS.

All the general close seasons for game prescribed by the various States and by the Provinces of Canada are here brought together in one table. For the sake of simplicity a uniform method is used in both the arrangement of species and statement of seasons. In each case deer and other big game are first considered; then squirrels and rabbits; then upland game birds, such as quail, grouse, pheasants, turkeys, and doves; then shore birds; and finally waterfowl, such as ducks, geese, and swans. In the statement of seasons only close seasons have been given, and in stating these the plan of the Vermont law, to include the first date, but not the last, has been followed consistently.[a] The Vermont scheme has the advantage of showing readily both the open and close seasons, since either may be obtained by reading the other backward.

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[a] Soldiers and sailors who are electors of the United States and who have been stationed in the State during the year immediately preceding are allowed to take out the $2 license.

In some States certain days of the week constitute additional close seasons throughout the term in which killing is permitted. Hunting on Sunday is prohibited in all except four of the States east of the Mississippi, and in Iowa, Kansas, Missouri, Minnesota, Nebraska, North Dakota, and Oklahoma, as well as in most of the Canadian Provinces. Mondays constitute a close season for waterfowl in Ohio and other week days for wild fowl in several favorite ducking grounds in Delaware, Maryland, Virginia, and North Carolina. Hunting is prohibited on election day in Baltimore, Frederick, and Harford counties, Maryland. These special exceptions, the county laws of Mississippi, of which no compilation is available, and the county laws of Alabama, Maryland, and North Carolina, which are too numerous to be included satisfactorily, are not given in the following table, which may otherwise be regarded as a practically complete résumé of the regulations now in force. The difficulty of securing absolute accuracy in a table of this kind is very great, and the absence in the laws of many States of express legislation as to the inclusion or exclusion of the dates opening and closing the seasons makes exactness almost an impossibility.

CLOSE SEASONS FOR GAME IN THE UNITED STATES AND CANADA, 1905.

[The close seasons include the first date, but not the last. To find the open seasons *reverse the data.* Seasons which apply only to special counties are placed to the left of the column containing the close seasons for the State in general. (See also Appendix, pp. 50–54.)]

Alabama (1899[b]) (*see county laws, pp. 50–51*):	*Close seasons.*
Deer	Jan. 1–Sept. 1.
Squirrel (black, gray, or fox)	Feb. 2–July 1.
Quail, partridge, grouse, prairie chicken, pheasant (including English, Mongolian, and Chinese), wild turkey, woodcock	Mar. 2–Nov. 15.
Dove	Mar. 1–Aug. 1.
Alaska[c] (1902–1904):	
Deer	Feb. 1–Aug. 1.
Moose, mountain sheep	Jan. 1–Sept. 1.
Caribou (except on Kenai Peninsula until Sept. 1, 1908, and in the rest of the Peninsula district[d] Nov. 1–Sept. 1)	Jan. 1–Sept. 1.

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[a] See discussion of this question in Circular No. 43 of the Biological Survey, U. S. Department of Agriculture, 1904, entitled "Definitions of open and close seasons for game."

[b] Under section 14 of the act all of the counties except 9 were excepted, and subsequent legislation has reduced the number until Houston County is practically the only one which still retains the close seasons of the original State law.

[c] Any game animal or bird may be killed at any time for food or clothing by native Indians or Eskimo or by miners, explorers, or travelers in need of food; but game so killed can not be shipped or sold.

[d] The Territory is divided into the following three game districts: (1) Sitka district—Southeastern Alaska east of the 141st meridian; (2) Peninsula district—Aleutian Islands, Alaska and Kenai peninsulas and adjacent islands, and that part of Alaska west of the 141st meridian draining into the Pacific Ocean; (3) Yukon district—Remainder of Territory, including the area drained by the Kuskokwim, Tanana, Yukon, and Kowak rivers, and the area which drains into the Arctic Ocean.

Alaska (1902-1904)—Continued.	*Close seasons.*
Mountain goat	Jan. 1-Aug. 1.
Bear (large brown)	Jan. 1-Apr. 1.
Grouse, shore birds	Dec. 16-Sept. 1.
Ptarmigan, waterfowl	Feb. 1-Sept. 1.
Arizona (1905):	
Male deer	Dec. 1-Sept. 15.
Female deer, spotted fawn, elk, mountain sheep, mountain goat	All the year.
Antelope, 6 years	Until Mar. 1, 1911.
Quail, bobwhite, partridge, grouse, pheasant, snipe, rail	Mar. 1-Oct. 15.
Introduced pheasant (Chinese, Japanese, green, golden, ring-neck, or Chinese ringless), 6 years	Until Mar. 1, 1911.
Wild turkey	Dec. 1-Sept. 15.
Arkansas[a] (1903):	
Deer (except Mississippi County, Mar. 1-Sept. 1)	Feb. 1-Sept. 1.
Quail or partridge (except Mississippi County, Mar. 1-Oct. 1)	Mar. 1-Nov. 1.
Pinnated grouse, prairie chicken	Dec. 1-Oct. 31.
Pheasants (Chinese, English), 10 years	Until Mar. 14, 1913.
Wild turkey	May 1-Sept. 1.
Dove	All the year.
California[b] (1901-1905):	
Male deer	Oct. 15-Aug. 1.
Female deer, fawn, elk, antelope, mountain sheep, tree squirrel	All the year.
Valley quail, partridge, plover, curlew, ibis, rail, shore birds, duck	Feb. 15-Oct. 15.
Mountain quail, grouse, sage hen	Feb. 15-Sept. 1.
Pheasants, bobwhite, imported quail, or partridge, swan	All the year.
Dove	Feb. 15-July 1.
Wilson snipe	Apr. 1-Oct. 15.
Colorado (1899-1905):	
Deer with horns	Oct. 21-Sept. 25.
Elk	Until Nov. 1, 1907.
Antelope	Until Oct. 15, 1907.
Mountain sheep, bison or buffalo	All the year.
Bobwhite quail, 17 years	Until Oct. 1, 1920.
Crested quail, 4 years	Until Nov. 1, 1907.
Wild turkey, 4 years	Until Sept. 1, 1907.
Pheasant, partridge, ptarmigan, crane	All the year.
Grouse, prairie chicken	Oct. 21-Sept. 1.
Sage chicken	Oct. 1-Aug. 1.
Dove	Aug. 16-Aug. 1.
Snipe, curlew, shore birds, duck, goose, brant, swan, waterfowl (see exception).	Apr. 16-Sept. 10.
Exception: Altitudes above 7,000 feet — May 1-Sept. 15.	
Connecticut (1901-1905):	
Deer, 10 years	Until June 1, 1911.
Gray squirrel, hare, rabbit	Dec. 1-Oct. 1.
Quail, ruffed grouse, woodcock, pheasant (Chinese, Mongolian)	Dec. 1-Oct. 1.
Dove	All the year.
Wilson or English snipe, bay snipe	May 1-Aug. 1.
Plover, rail, gallinule, mud hen	Apr. 1-Sept. 1.
Web-footed wild fowl	May 1-Sept. 1.
Delaware (1893-1905):	
Squirrel (other than red and only in Kent and Newcastle counties), rabbit	Jan. 1-Nov. 15.
Quail, partridge, pheasant	Jan. 1-Nov. 15.
Dove	All the year.
Reedbird, ortolan or rail	Feb. 2-Sept. 1.
Duck (except wood duck), goose, brant, swan	Apr. 16-Oct. 1.
District of Columbia (1899-1901):	
Deer meat (sale or possession)	Jan. 1-Sept. 1.
Squirrel, rabbit (except English rabbit, Belgian hare)	Feb. 1-Nov. 1.
Quail or partridge	Mar. 15-Nov. 1.
Ruffed grouse or pheasant (except English, ringneck, or other imported pheasants raised in inclosures, sale or possession unrestricted), wild turkey.	Dec. 26-Nov. 1.
Prairie chicken or pinnated grouse	Mar. 15-Sept. 1.

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[a] Laws of 1906 not yet received.

[b] Seasons fixed by ordinances of Boards of County Supervisors are omitted (see explanation on p. 50).

District of Columbia (1899-1900)—Continued.	*Close seasons.*
Dove	All the year.
Woodcock	Jan. 1-July 1.
Snipe, plover, duck, goose, brant	Apr. 1-Sept. 1.
Reedbird, marsh blackbird, rail or ortolan, other game birds not previously mentioned	Feb. 1-Sept. 1.
Florida[a] (1903):	
Deer	Feb. 1-Nov. 1.
Quail or partridge, wild turkey	Mar. 1-Nov. 1.
Duck	Apr. 1-Oct. 1.
Georgia (1903-1905):	
Deer	Jan. 1-Sept. 1.
Quail, partridge, pheasant, wild turkey	Mar. 15-Nov. 1.
Dove, snipe, marsh hen	Mar. 15-Sept. 1.
Woodcock, wood duck or summer duck	Feb. 1-Sept. 1.
Hawaii (1897):	
Quail, pheasant	Mar. 1-Sept. 16.
Wild dove, wild pigeon	Feb. 1-July 1.
Koleá (plover), ákeeki (lesser pied plover), kukuluaeo (long-legged plover)	Aug. 1-Mar. 1.
Imported birds, 10 years	Until 1907.
Snipe, plover, turnstone, curlew, stilt, mud hen, migratory duck	May 1-Sept. 16.
Native wild duck, Hawaiian goose	Feb. 1-Sept. 16.
Idaho (1905):	
Deer, elk, mountain sheep, mountain goat	Jan. 1-Sept. 1.
Moose, caribou, antelope, buffalo	All the year.
Quail	Dec. 1-Nov. 1.
Partridge, grouse, prairie chicken or fool hen, pheasant	Dec. 1-Aug. 15.
Sage hen	Dec. 1-July 15.
Mongolian pheasant, 4 years	Until Mar. 6, 1909.
Turtle dove, snipe, plover	Nov. 1-Aug. 1.
Duck, goose, swan	Feb. 1-Sept. 1
Illinois (1903-1905):	
Deer, 10 years	Until Apr. 28, 1913.
Squirrel (gray, red, fox, or black)	Jan. 1-July 1.
Quail	Dec. 20-Nov. 10.
Ruffed grouse, prairie chicken, 4 years	Until May 18, 1909.
Wild turkey, pheasants (copper or Soemmering, English, golden, green Japanese, Mongolian, ring-neck, silver, tragopan), partridge (black Indian, caccabis, chukar), sand grouse, 5 years	Until Apr. 28, 1908.
Mourning dove, woodcock	Dec. 1-Aug. 1.
Jacksnipe or Wilson snipe, sand or other snipe, golden, upland, or other plover	May 1-Sept. 1.
Duck, goose, brant, or other waterfowl	Apr. 15-Sept. 1.
Indiana (1905):	
Deer	All the year.
Squirrel	Jan. 1-Nov. 10.[b]
Rabbit	Oct. 1-Nov. 10.
Quail, ruffed grouse, prairie chicken, or pinnated grouse	Jan. 1-Nov. 10.
Pheasants (except copper, golden, Japanese, Mongolian, silver, 6 years, until Feb. 24, 1911), wild turkey	All the year.
Dove	Jan. 1-Nov. 10.[c]
Duck, groose, brant, or other waterfowl	Apr. 15-Sept. 1.
All game except waterfowl	Oct. 1-Nov. 10.
Iowa (1897-1904):	
Deer, elk	All the year.
Squirrel (gray, timber, or fox)	Jan. 1-Sept. 1.
Quail, ruffed grouse or pheasant, wild turkey	Dec. 15-Nov. 1.
Pinnated grouse or prairie chicken	Dec. 1-Sept. 1.
Turtle dove	All the year.
Woodcock	Jan. 1-July 10.
Snipe, sandpiper, plover, rail, marsh or beach birds, duck, goose, brant	Apr. 15-Sept. 1.

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[a] It is unlawful to kill game or game birds within 1 mile of West Palm Beach; similar regulations are in force at St. Augustine.

[b] Except Aug. 1-Oct. 1.

[c] Except Aug. 15-Oct. 1.

	Close seasons.
Kansas (1903-1905):	
Antelope, 5 years	Until Mar. 13, 1908
Red squirrel	All the year.
Quail (see exceptions)	Dec. 15-Nov. 15.[a]
Exceptions: Bourbon, Crawford, Decatur, Finney, Grant, Gray, Greeley, Hamilton, Haskell, Hodgeman, Morton, Rooks, Scott, Sherman, Smith, Stafford, Stanton, Stevens, and Wichita counties, 3 years. Until Mar. 11, 1908.	
Grouse, prairie chicken (see exceptions)	Oct. 15-Sept. 15.[a]
Exceptions: Prairie chicken in same counties as in case of quail. Until Mar. 11, 1908.	
Pheasants (Chinese, Mongolian), 4 years	Until Feb. 28, 1907
Dove	Sept. 15-Aug. 1.
Plover	Sept. 15-July 15.
Duck, goose, brant	Apr. 15-Sept. 1.
Kentucky (1894-1904):	
Deer	Mar. 1-Sept. 1.
Rabbit (except with dogs or in snares)	Sept. 15-Nov. 15.
Squirrel (black, gray, or fox)	Feb. 1-Nov. 15.[b]
Quail, partridge, pheasant	Jan. 1-Nov. 15.
Wild turkey	Feb. 1-Sept. 1.
Dove	Feb. 1-Aug. 1.
Woodcock	Feb. 1-June 20.
Wood duck, teal, or other duck, goose	Apr. 1-Aug. 15.
Louisiana (1904):	
Deer (female and young protected all the year)	Local seasons.[c]
Quail	Mar. 1-Nov. 1.
Prairie chicken, wood duck, 5 years	Until July, 1909.
Male wild turkey (female protected all the year)	Apr. 1-Dec. 1.
Woodcock	All the year.
Snipe	May 1-Sept. 1.
Dove, grosbec, surf bird, chorook, sandpiper, plover, tatler, curlew, rail (mudhen), gallinule, coot (poule d'eau)	Mar. 1-Aug. 1.
Duck (except wood duck), goose, brant, swan	Apr. 15-Sept. 1.
Maine (1903-1905):	
Deer (see exceptions)	Dec. 16-Oct. 1.
Exceptions: Androscoggin County ... Nov. 1-Oct. 1	
Counties of Cumberland, Kennebec, Knox, Lincoln, Sagadahoc (except towns of Bath, West Bath, and Phippsburg, all the year), Waldo and York (except towns of Eliot, Kittery, Wells, and York, all the year) Dec. 1-Nov. 1	
Hancock County—In towns of Eden, Mount Desert, Southwest Harbor, and Tremont, Dec. 15-Nov. 15; Isle au Haut (on islands) until Oct. 1, 1907, and Swan Island until Dec. 15, 1908; otherwise as in State law.	
Bull moose	Dec. 1-Oct. 15.
Cow and calf moose	All the year.
Caribou, 6 years	Until Oct. 15, 1911.
Squirrel (in Knox County)[d] ... All the year.	
Rabbit	Apr. 1-Sept. 1.
Quail, dove	All the year.
Ruffed grouse or partridge, woodcock	Dec. 1-Sept. 15.
Pheasant, black game, capercailzie or cock of the woods, 10 years	Until Apr. 28, 1913.
Snipe, sandpiper, plover	May 1-Aug. 1.
Wood duck, dusky or black duck, teal, gadwall or gray duck, mallard, widgeon or baldpate, shoveler, pintail or sprigtail, redhead, scaup or greater bluebill, lesser scaup or lesser bluebill, golden-eye or whistler, bufflehead, ruddy duck, or broadbill	Dec. 1-Sept. 1.
All ducks on the Kennebec River below Gardiner and in Merrymeeting Bay	Dec. 1-Sept. 1.

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[a] In Rawlins County, a land owner, his family, guest, or servant may shoot quail, grouse, or prairie chickens on the premises Nov. 1-Jan. 1.

[b] Except June 15-Sept. 15.

[c] Close seasons for deer in Louisiana, not less than 7 months in length, to be fixed by police juries of the several parishes, but north of Lat. 31 the period from May 1 to Aug. 15 to be always included.

[d] Gray squirrels protected all the year in Fryeburg, Oxford County.

Maryland (1898–1904) (*see county laws, pp. 51–52*):	*Close seasons.*
Squirrel	Dec. 1–Sept. 1.
Pheasants (English, Mongolian)	Dec. 25–Nov. 1.
Dove	Dec. 25–Aug. 15.
Snipe, plover	May 1–Aug. 15.
Reedbird, sora (water rail or ortolan)	Nov. 1–Sept. 1.
Duck, goose, brant, swan, and other wild fowl	Apr. 10–Nov. 1.
Massachusetts (1902–1905):	
Deer, 5 years	Until Nov. 1, 1906.
Gray squirrel (except Bristol County, Dec. 15–Nov. 1), hare, or rabbit (except Bristol County, Mar. 1–Nov. 1)	Mar. 1–Oct. 1.
Quail (see exceptions)	Dec. 1–Nov. 1.
Exceptions: Bristol County .... Dec. 15–Nov. 1.	
Nantucket Island, 3 years .... Until Mar. 1, 1908.	
Ruffed grouse or partridge, woodcock (see exception)	Dec. 1–Oct. 1.
Exception: Bristol County .... Dec. 15–Nov. 1.	
Pinnated grouse, dove, wild, or passenger pigeon	All the year.
Pheasants (English, golden, Mongolian), 2 years	Until Oct. 1, 1907.
Snipe, sandpiper, plover (except upland plover), rail, or any "shore," "marsh," or "beach" birds	Mar. 1–July 15.
Bartramian sandpiper (upland plover)	Until July 15, 1910.
Wood or summer duck, black duck, teal	Mar. 1–Sept. 1.
Other ducks	May 20–Sept. 1.
Michigan (1905):	
Deer (see exceptions)	Dec. 1–Nov. 10.
Exceptions: Deer in red coat and fawn in spotted coat	All the year.
Deer on Bois Blanc and Grand islands, and in Allegan, Benzie, Clare, Gladwin, Grand Traverse, Huron, Isabella, Lake, Lapeer, Leelanau, Macomb, Manistee, Mason, Mecosta, Missaukee, Newaygo, Oceana, Osceola, Ottawa, St. Clair, Sanilac, Tuscola, and Wexford counties .... Until Jan. 1, 1908	
Kalkaska County .... Until 1910	
Elk, moose, caribou, 8 years	Until June 16, 1913
Squirrel (black, fox, or gray)	Dec. 1–Oct. 15.
Quail (bobwhite)	Until Oct. 15, 1907
Ruffed grouse (partridge), spruce hen (see exception)	Dec. 1–Oct. 15.
Exception: Ruffed grouse, spruce hen (Upper Peninsula) .... Dec. 1–Oct. 1	
Pinnated grouse (prairie chicken), wild turkey, capercailzie, black game, hazel grouse, pheasants (English, Mongolian), wild pigeon	Until 1910.
Partridge, Manitoba grouse, dalripan (European ptarmigan), ptarmigan on Grand Island, Alger County	Until 1910.
Dove	All the year.
Snipe, plover, woodcock, duck, goose, brant, or other waterfowl (except that bluebill, canvasback, widgeon, redhead, pintail, whistler, spoonbill, butterball, and sawbill duck, goose, and brant may be hunted also Mar. 15–Apr. 11)	Jan. 2–Sept. 1.
Minnesota (1905):	
Deer, male moose	Dec. 1–Nov. 10.
Elk, female moose, caribou, fawn	All the year.
Quail, partridge, ruffed grouse (pheasant)	Dec. 1–Oct. 1.
Sharp-tailed or white-breasted grouse, pinnated grouse or prairie chicken, turtle dove, woodcock, snipe, upland plover, golden plover	Nov. 1–Sept. 1.
Pheasants (Chinese, English, Mongolian, golden, Reeves, Japanese, Tragopan, Temminck)	Until Jan. 1, 1910.
Duck, goose, brant, or any aquatic fowl	Dec. 1–Sept. 1.
Mississippi[a] (1892):	
Deer	Mar. 1–Sept. 15.
Quail (partridge), wild turkey	May 1–Oct. 1.
Turtle or mourning dove, starling (field lark)	Mar. 1–Sept. 15.
Missouri (1905):	
Deer (except does and young less than 1 year old, protected all the year)	Jan. 1–Nov. 1.
Squirrels (gray, black, fox)	Jan. 1–July 1.
Quail (bobwhite, partridge), wild turkey	Jan. 1–Nov. 1.
Pinnated grouse (prairie chicken)	Dec. 15–Nov. 15.
Ruffed grouse (pheasant), Mongolian, Chinese, and English pheasants, and other imported game birds	Until Dec. 1, 1910.

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[a] County laws in force.

	Close seasons.
issouri (1905)—Continued.	
Turtle dove, woodcock, plover	Jan. 1-Aug. 1.
Snipe, duck, goose	May 1-Sept. 15.
ontana (1905):	
Deer, elk, mountain goat, mountain sheep	Dec. 1-Sept. 1.
Moose, female elk, caribou, antelope, bison or buffalo	All the year.
Quail, Chinese pheasant	All the year.
Grouse, prairie chicken, fool hen, pheasant, partridge, sage hen, turtle dove, duck, goose, brant, swan	Dec. 1-Sept. 1.
ebraska (1901-1905):	
Deer with horns, antelope with horns	Nov. 16-Aug. 15.
Deer and antelope without horns, elk, squirrel (gray, red, fox, timber)	All the year.
Quail	Dec. 1-Nov. 15.
Partridge, pheasant, ptarmigan, Mongolian pheasant, China pheasant, imported game birds, wild turkey, curlew	All the year.
Prairie chicken, sage chicken, grouse	Dec. 1-Sept. 1.
Dove, wild pigeon, plover	Aug. 1-July 1.
Jacksnipe or Wilson snipe, yellowlegs (other snipe protected all the year)	May 16-Sept. 1.
Crane, duck, goose, brant, or any game waterfowl	Apr. 16-Sept. 1.
evada[a] (1901-1903):	
Deer, antelope (males)	Nov. 15-Sept. 15.
Female deer and antelope, spotted fawn; all elk, caribou, mountain sheep, mountain goat	All the year.
Quail, grouse, prairie chicken, woodcock, snipe, plover, curlew, sandhill crane, duck	Mar. 1-Sept. 15.
Pheasant, 5 years	Until Sept. 1, 1906.
Sage hen	Feb. 16-July 15.
Dove	Nov. 2-July 15.
Swan	All the year.
ew Hampshire (1901-1905):	
Deer in Carroll, Coos, and Grafton counties, and in the towns of Andover, Danbury, Hill, Salisbury, Sutton, Warner, Webster, and Wilmot in Merrimack County	Dec. 1-Oct. 1.
Deer in rest of State, elk, moose, caribou	All the year.
Gray squirrel, raccoon	Jan. 1-Sept. 15.
Hare, rabbit	Apr. 1-Oct. 1.
Quail, patridge, ruffed grouse, woodcock, Wilson snipe	Dec. 15-Oct. 1.
Dove	All the year.
Sandpiper, yellow-legs, plover, rail, duck (except sheldrake), ("beach birds" may be shot in Rockingham County after July 15)	Feb. 1-Aug. 1.
ew Jersey (1903-1904):	
Deer,[b] 2 years	Until Apr. 5, 1906.
Squirrels (gray, black, fox), hare (rabbit)	Jan. 1-Nov. 10.
Quail (partridge), ruffed grouse (partridge or pheasant) prairie chicken, pheasant (English or ring-neck pheasant),[c] wild turkey	Jan. 1-Nov. 10.
Dove	All the year.
Woodcock	Jan. 1-Oct. 1.[d]
English or Wilson snipe (bog or jack snipe)	Jan. 1-Sept 1.[e]
Surf or bay snipe, sandpiper, yellow-legs, plover (except upland plover), curlew, all shore birds	Jan. 1-May 1.
Upland plover	Oct. 1-Aug. 1.
Reedbird, rail, marsh hen	Jan. 1-Sept. 1.
Duck, goose, brant, swan, or other wild fowl	May 1-Sept. 1.
ew Mexico (1905):	
Deer.(with horns)	Nov. 1-Sept. 15.
Deer (without horns), elk, mountain sheep	All the year.
Antelope 5 years	Until Mar. 13, 1910.

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[a] County commissioners may change dates of close seasons (without altering length) for deer, telope, or sage hens, or lengthen close seasons for any other game in their respective counties.

[b] Does not apply to deer in game preserves or to possession of imported deer properly tagged.

[c] English or ring-neck pheasants in established game preserves may be shot by the owners of such serves or such persons as they may designate Oct. 1-Jan. 1.

[d] Except month of July.

[e] Except March and April.

New Mexico (1905)—Continued. *Close season*

Quail (native or crested), mountain grouse, prairie chicken, wild turkey ..... Jan. 1–Oct. 1.
Bobwhite quail, pheasants, wild pigeon, 5 years ..... Until Mar. 13,
Ptarmigan ..... All the year.
Turtle dove ..... Oct. 1–Aug. 1.

New York (1900–1905) (*see special laws for Long Island below*):

Deer (see exceptions) ..... Nov. 16–Sept.
Exceptions: Columbia, Delaware, Dutchess, Greene, Oswego, Putnam, Rensselaer, Rockland, Ulster, and Westchester counties, and all of Oneida, Lewis, and Jefferson counties west of the Utica and Black River R. R. from Utica to Ogdensburg, 3 years ..... Until Sept. 1, 1907
Orange and Sullivan counties ..... Nov. 16–Nov. 1
Fawns, elk, moose, caribou, antelope ..... All the year.
Black bear (except in Essex County, unprotected) ..... July 1–Oct. 1.
Squirrel, black or gray (see exceptions) ..... Dec. 1–Sept. 16
Exceptions: Chautauqua County ..... Dec. 1–Oct. 16
Dutchess, Rensselaer, and Sullivan counties ..... Dec. 1–Oct. 1
Greene County ..... Dec. 16–Oct. 1
Orange County ..... Dec. 16–Oct. 16
Richmond County (gray squirrel only) ..... All the year
Saratoga County ..... Nov. 1–Sept. 16
Hare, rabbit:
Albany, Columbia, Genesee, Monroe, Orleans, and Wyoming counties ..... Dec. 16–Sept. 16
Broome and Cortland counties ..... Dec. 1–Sept. 16
Dutchess County ..... Dec. 1–Oct. 16
Erie, Madison, Rensselaer, Steuben, and Sullivan counties ..... Feb. 16–Oct. 1
Fulton, Greene, and Schenectady counties ..... Feb. 1–Nov. 1
Herkimer and Oneida counties ..... Feb. 15–Sept. 16
Livingston and Ulster counties ..... Jan. 16–Oct. 1
Orange County ..... Dec. 16–Oct. 16
Richmond County ..... Dec. 16–Nov. 1
Rockland County ..... Dec. 31–Nov. 1
Westchester County ..... Dec. 1–Nov. 1
Quail (see exceptions) ..... Dec. 1–Nov. 1.
Exceptions: Cattaraugus and Chautauqua counties ..... Dec. 1–Oct. 16
Orange and Ulster counties ..... Dec. 16–Oct. 16
Rensselaer County ..... Dec. 1–Oct. 1
Richmond County, 2 years ..... Until 1908
Saratoga, Schenectady, and Schoharie counties, 2 years ..... Until 1906
Grouse (see exceptions) ..... Dec. 1–Sept. 16.
Exceptions: Cattaraugus and Chautauqua counties ..... Dec. 1–Oct. 16
Dutchess, Greene, Rensselaer, Sullivan, and Tioga counties ..... Dec. 1–Oct. 1
Orange and Ulster counties ..... Dec. 16–Oct. 16
Saratoga County ..... Nov. 1–Sept. 16
Schenectady County, 2 years ..... Until 1906
Pheasants (Mongolian, ring-neck, English) 6 years ..... Until 1910.
Dove ..... All the year.
Woodcock (see exceptions) ..... Dec. 1–Sept. 16.
Exceptions: Cattaraugus and Chautauqua counties ..... Dec. 1–Oct. 16
Dutchess, Greene, Rensselaer, Sullivan, and Tioga counties ..... Dec. 1–Oct. 1
Orange and Ulster counties ..... Dec. 16–Oct. 16
Saratoga County ..... Nov. 1–Sept. 16
Schenectady County, 2 years ..... Until 1906
Plover ..... Jan. 1–Aug. 16.
Wilson or English snipe, jacksnipe, bay snipe, yellow-legs, surf birds, curlew, rail, water chicken, mud hen, gallinule, shore birds, duck, goose, brant, swan ..... Jan. 1–Sept. 16.

Long Island (1900–1905):

Deer shooting permitted only on first two Wednesdays and Fridays after first Tuesday of November (Nov. 8, 10, 15, and 17 in 1905).
Squirrel (black or gray), hare, rabbit ..... Jan. 1–Nov. 1.
Quail (except on Robbins Island, protected all the year; and Gardiners Island, Feb. 1–Oct. 15), grouse ..... Jan. 1–Nov. 1.
Woodcock ..... Jan. 1–Aug. 1.
Pheasants (English, Mongolian, ring-neck), in Suffolk Co ..... Jan. 1–Nov. 1

	Close seasons.
Long Island (1900-1905)—Continued.	
Wilson or English snipe, jacksnipe, bay snipe, surf snipe, winter snipe, sandpiper, yellow-legs, willet, dowitcher, short-necks, plover, ring-neck, killdeer, oxeye, curlew, rail	Jan. 1-July 16.
Gallinule, meadow hen, mud hen	Dec. 31-Aug. 16.
Duck, goose, swan	Jan. 1-Oct. 1.
Brant	May 1-Oct. 1.
North Carolina (1883-1903) (*see county laws; pp. 53-54*):	
Deer	Jan. 1-Oct. 1.
Quail, wild turkey, dove	Mar. 15-Nov. 1.
North Dakota (1901):	
Deer	Dec. 1-Nov. 10.
Elk, moose, caribou, buffalo, mountain sheep	All the year.
Antelope, 10 years	Until Jan. 1, 1911.
Quail, pheasants (English, Chinese), sharp-tailed grouse, ruffed grouse, pinnated grouse, prairie chicken, woodcock, swan	Oct. 15-Sept. 1.
Crane, duck, goose, brant	May 1-Sept. 1.
Ohio (1900-1904):	
Squirrel	Oct. 15-Sept. 1.
Rabbit	Dec. 5-Nov. 15.[a]
Raccoon	Mar. 1-Sept. 1.
Quail	Dec. 5-Nov. 15.
Ruffed grouse, introduced pheasants, 4 years	Until Nov. 10, 190
Dove, woodcock	Dec. 1-Sept. 1.
Snipe, plover, shore birds, rail, coot or mudhen, duck, goose, swan	Dec. 1-Sept. 1.[b]
Oklahoma (1899):	
Deer, antelope	All the year.
Quail	Feb. 1-Oct. 15.
Grouse	All the year.
Prairie chicken, wild turkey	Jan. 1-Sept. 1.
Pheasants (Mongolian or others)	Jan. 1-Dec. 1.
Dove, plover	Jan. 1-Aug. 1.
Oregon (1901-1905):	
Male deer (except in Baker, Grant, Harney, and Malheur counties)	Nov. 1-Aug. 15.
Female deer (except in above 4 counties)	Nov. 1-Sept. 1.
Spotted fawn	All the year.
Elk, 4 years	Until Sept. 15, 190
Silver gray squirrel (*Sciurus fossor*)	Jan. 1-Oct. 1.
Partridge (English or gray), capercailzie, moor hen, pheasant (silver, golden, copper, green Japanese, and Reeves), wild turkey, woodcock	Dec. 1-Oct. 1.
Prairie chicken (see exceptions)	Until Sept. 15, 19
Exceptions: Wasco County ... Oct. 15-Aug. 1	
Umatilla County ... Dec. 1-Oct. 1	
Upland plover, rail	Jan. 1-Aug. 1.
Duck, goose,[c] swan (except in Lake County, Apr. 1-Aug. 15, and in Coos County, Feb. 1-Aug. 1)	Feb. 1-Sept. 1.
West of Cascades (see exceptions):	
Quail, bobwhite, partridge, grouse, native pheasant (ruffed grouse), ring-neck or China torquatus pheasant	Dec. 1-Oct. 1.
Exceptions: Douglas County: Quail, bobwhite, partridge, native pheasant, ring-neck or China torquatus pheasant ... Dec. 1-Sept. 1?	
Grouse, ruffed grouse ... Dec. 1-Aug. 1?	
Tillamook County: Native pheasant (ruffed grouse), ring-neck or China torquatus pheasant ... Dec. 1-Sept. 15	
Blue grouse ... Oct. 15-Aug. 1	
Clatsop, Coos, Curry, Jackson, and Josephine counties: Ring-neck or China torquatus pheasant, 3 years ... Until Sept. 15, 1906	
East of Cascades:	
Quail (see exception) hunting permitted only from second Saturday to third Tuesday in September—(Sept. 9-19, 1905)	
Exception: Wasco County ... Oct. 15-Aug. 1	

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[a] Applies to hunting with *gun* only.

[b] Except Mar. 1-Apr. 20.

[c] Unlawful to kill geese at any time on islands or sand bars on which they habitually rest in th
Columbia River east of the Cascades.

Oregon (1901-1905)—Continued.

East of Cascades—Continued.	*Close seasons.*
Pheasant	All the year.
Native pheasant (ruffed grouse), grouse, sage hen	Dec. 1-Aug. 15.
Mongolian, ring-neck (China torquatus) pheasant	Until Feb. 15, 1910.
Pennsylvania (1905):	
Deer	Dec. 1-Nov. 15.
Bear	Mar. 1-Oct. 1.
Squirrel	Dec. 1-Oct. 1.
Hare, rabbit	Dec. 1-Nov. 1.
Quail	Dec. 1-Nov. 1.
Ruffed grouse (pheasant), prairie chicken, imported pheasants (Chinese, English, Mongolian), wild turkey	Dec. 1-Oct. 15.
Wild pigeon	Until Apr. 22, 1915.
Dove, reed bird, rail, blackbird, sandpiper, tatler, curlew, or any shore bird	Jan. 1-Sept. 1.
Woodcock	Dec. 1-Oct. 1.
Wilson snipe (jacksnipe)	May 1-Sept. 1.
Upland or grass plover	Dec. 1-July 15.
Duck, goose, brant, swan, coot, mudhen	Jan. 1-Sept. 1.[a]
Rhode Island (1900-1905):	
Deer, 4 years	Until Jan. 1, 1908.[b]
Gray squirrel, hare, rabbit	Jan. 1-Nov. 1.
Quail or bobwhite, ruffed grouse or partridge, woodcock	Jan. 1-Nov. 1.
Pheasant, 5 years	Until Oct. 15, 1910
Dove	All the year.
Black duck and wood duck	Apr. 1-Aug. 15.
South Carolina (1902-1905):	
Deer (see exceptions)	Jan. 1-Sept. 1.
Exceptions: Beaufort, Berkeley, Clarendon, Colleton, Darlington, Florence, Hampton, Horry, Kershaw, Marion, and Marlboro counties.	Feb. 1-Aug. 1
Quail, partridge, pheasant, wild turkey, woodcock	Apr. 1-Nov. 1.
Dove	Mar. 1-Nov. 1.
South Dakota (1899-1905):	
Deer, elk, buffalo, mountain sheep	Dec. 1-Nov. 1.
Antelope, 10 years	Until Jan. 1, 1911.
Quail, ruffed grouse, sharp-tailed grouse, pinnated grouse, prairie chicken, woodcock	Jan. 1-Sept. 1.
Plover, curlew	May 15-Sept. 1.
Crane, duck, goose, brant	May 1-Sept. 1.
Tennessee[c] (1903-1905):	
Deer	Until Oct. 1, 1907.
Squirrel	Mar. 1-June 1.
Quail or partridge, pheasant (except English, ring-neck, or Mongolian, until Nov. 1, 1907), prairie chicken, grouse, wild turkey, meadow lark	Mar. 1-Nov. 1.
Dove, teal, wood (summer) duck	Apr. 15-Aug. 1.

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[a] Except Apr. 1-16.

[b] Tame deer kept in confinement may be killed by owner at any time.

[c] *Exceptions to State law:*

Cannon, Carroll, Clay, Coffee, Dekalb, Dyer, Fayette, Fentress, Franklin, Hamilton, Henry, Houston, Lake, Lawrence, Lewis, Lincoln, Macon, Marshall, Monroe, Montgomery, Overton, Pickett, Putnam, Robertson, Rutherford, Smith, Stewart, Wayne, Wilson: Deer, Dec. 15-Oct. 1; English pheasant, Jan. 1-Oct. 1; dove, wood duck, Mar. 1-Aug. 1; teal, Apr. 15-Oct. 1.

Hardeman: Deer, until Nov. 1, 1907; squirrel, Mar. 1-July 15; dove, wood duck, Mar. 1-Aug. 1; teal, Apr. 15-Oct. 1.

Warren: Deer, Jan. 1-Nov. 1; English pheasant, Jan. 1-Oct. 1; squirrel, unprotected: dove, Mar. 1-Aug. 1; teal, wood duck, Apr. 15-Oct. 1; woodcock, snipe, sandpiper, plover, tatler, godwit, curlew, avocet, marsh blackbird, rail, coot, mud hen, Mar. 1-Sept. 1.

Special squirrel seasons: Cannon, Mar. 1-June 1 (?); Crockett, Jan. 1-June 1; Dyer, Jan. 1-July 1; Fayette, Jan. 1-July 15(?); Haywood, Jan. 1-May 1; Henderson, Jan. 15-July 15; McNairy, Madison, Sevier, Mar. 1-May 1; Shelby, Feb. 1-June 15; Bedford, Blount, Dickson, Giles, Greene, Hickman, Knox, Lincoln, Loudon, Meigs, Moore, Washington, Williamson, unprotected.

Special wild turkey seasons: Dyer (gobblers), May 1-Nov. 1; Haywood (gobblers), May 1-Dec. 1; (hens), Feb. 1-Nov. 1.

Tennessee (1903-1905)—Continued.	*Close seasons.*
Woodcock, snipe, sandpiper, plover, tatler, godwit, curlew, avocet, marsh blackbird, rail, coot, mud hen, duck (except teal and wood duck), goose, brant, swan	Apr. 15-Oct. 1
Texas (1903):	
Deer (female deer and spotted fawn, protected all the year)	Jan. 1-Nov. 1
Antelope, mountain sheep, 5 years	Until July 1, 1908.
Quail or partridge, prairie chicken or pinnated grouse, wild turkey	Feb. 1-Nov. 1.
Pheasants (Mongolian, English), 5 years	Until July 1, 1908.
Dove	Feb. 1-Sept. 1.
Utah (1905):	
Deer, elk, antelope, sheep, any introduced game	Until Mar. 17 1909
Quail (see exception), pinnated grouse, pheasants (English, Mongolian, Chinese)	All the year.
Exception: Quail, Kane and Washington counties	Feb. 1-Aug. 1
Davis, Salt Lake, and Weber counties	Oct. 11-Oct. 1
Partridge, grouse, prairie chicken, sage hen, pheasant, mourning dove	Dec. 1-Aug. 15.
Snipe, shore birds, duck, goose, brant, swan	Jan. 1-Oct. 1.
Vermont (1894-1903):	
Deer (with horns not less than 3 inches long) entire year except Oct. 23-29...	
Deer (without horns 3 inches long), moose, caribou	All the year.
Hare, rabbit	May 1-Sept. 1.
Quail, ruffed grouse or partridge, woodcock, English snipe, plover (other than upland), duck, goose	Jan. 1-Sept. 1.
Pheasant, English partridge	Until Oct. 1, 1909
Dove	All the year.
Upland plover	Dec. 1-Aug. 15.
Virginia [a] (1903-1904):	
Deer	Jan. 1-Oct. 1.
Squirrel:	
Alexandria County (gray)	Until Sept. 1, 1910
Isle of Wight and Southampton counties (gray or fox)	Jan. 15-Sept. 1
Rabbit:	
Accomac and Northampton counties	Jan. 15-Nov. 15
Alexandria, Fairfax, Fauquier, Loudoun, and Prince William counties.	Jan. 1-Nov. 1
Amelia,[b] Charlotte,[b] Greenesville, Spottsylvania, and Sussex counties.	Feb. 1-Oct. 1
Buckingham [b] and Cumberland [b] counties	Feb. 15-Oct. 15
Caroline, Essex, Hanover, Henrico, and King William counties.	Feb. 1-Nov. 1
Chesterfield County	Feb. 1-Sept. 1
Culpeper and Orange counties	Jan. 15-Nov. 1
Elizabeth City and Norfolk counties	Feb. 1-Nov. 15
Halifax County	Feb. 1-Oct. 15
James City and York counties, town of Williamsburg	Feb. 15-Nov. 15
Nottoway County	Jan. 1-Sept. 1
Shenandoah County	Mar. 1-Nov. 1
Stafford County	Feb. 1-Sept. 15
Opossum:	
Halifax County	Feb. 1-Oct. 15
Quail or partridge, pheasant or grouse, wild turkey, woodcock (see exceptions)	Feb. 1-Nov. 1.
Exceptions: West of the Blue Ridge	Jan. 1-Nov. 1
Accomac and Northampton counties (pheasant, grouse—5 years).	Until Mar. 14, 1909
Pheasants (English, Mongolian), 5 years	Until Jan. 1, 1909.
Dove	All the year.
Snipe (except Wilson snipe), surf bird, sandpiper, plover, willet, tatler, curlew, rail (except sora), gallinule, mud hen	Jan. 1-July 20.

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[a] Boards of supervisors may shorten the open seasons in their counties and make other restrictions not repugnant to laws.

[b] Young rabbits or hares may be killed or captured June 1-Aug. 1 in Amelia and Charlotte counties, and June 1-Oct. 15 in Buckingham and Cumberland counties.

Virginia (1903-1904)—Continued.	*Close seasons.*
Summer or wood duck	Jan. 1-Aug. 1.
Winter waterfowl	Apr. 1-Oct. 15.
Washington[a] (1903-1905):	
Deer (except deer on islands and spotted fawn, protected all the year)	Dec. 15-Sept. 15.
Elk	Until Oct. 1, 1915.
Moose, caribou, antelope, sheep, goat (males)	Nov. 1-Sept. 15.
Moose, caribou, antelope, sheep, goat (females)	All the year.
Quail west of Cascades (except Chinese quail) ..... Jan. 1-Oct. 1	
Quail east of Cascades, 5 years ..... Until Sept. 15, 1908	
Chinese quail west of Cascades, 3 years ..... Until Oct. 15, 1906	
Partridge, grouse, prairie chicken, sage hen, native pheasant, ptarmigan (except east of Cascades, Nov. 15-Aug. 15; prairie chicken in Kittitas County, Oct. 1-Sept. 10)	Jan. 1-Sept. 1.
Imported pheasants (golden, silver, ring-neck, copper, bronze, Chinese or Mongolian, except east of Cascades, until Sept. 15, 1908, and female pheasants until Oct. 15, 1906)	Jan. 1-Oct. 15.
Dove	All the year.
Snipe, sand-hill crane, duck, swan (see exceptions)	Mar. 1-Sept. 1.
Exceptions: Goose, brant, or other waterfowl on Columbia and Snake Rivers, or within half a mile of their shores, in Columbia, Douglas, Franklin, Garfield, Klickitat, Kittitas, Wallawalla, Whitman, and Yakima counties ..... All the year	
Goose, brant (except as above)	May 1-Sept. 1.
Plover, rail	Mar. 1-Aug. 15.
West Virginia (1903):	
Deer (except spotted fawn, protected all the year)	Dec. 16-Oct. 15.
Squirrel, rabbit	Jan. 1-Sept. 15.
Quail or Virginia partridge	Dec. 20-Nov. 1.
Ruffed grouse, pheasant, pinnated grouse or prairie chicken, wild turkey	Dec. 15-Oct. 15.
Dove	All the year.
Woodcock	Nov. 2-July 15.
Snipe	July 1-Mar. 1.
Duck, goose, brant	Apr. 1-Oct. 1.
Wisconsin (1898-1905):	
Deer (see exceptions)	Dec. 1-Nov. 11.
Exceptions: La Crosse, Monroe, Trempealeau, and Vernon counties, 4 years ..... Until Nov. 10, 1907	
Adams, Marquette, and Richland counties ..... Dec. 1-Nov. 21	
Calumet, Columbia, Fond du Lac, Manitowoc, Sauk, and Sheboygan counties ..... All the year	
Squirrel (gray, black, fox), rabbit	Mar. 1-Sept. 1.
Quail, pheasants (Chinese, English, Mongolian), 5 years	Until Oct. 1, 1910.
Partridge, grouse, pheasant, woodcock, snipe, plover	Dec. 1-Sept. 1.
Prairie chicken in Adams, Barron, Burnett, Bayfield, Buffalo, Clark, Crawford, Douglas, Dunn, Eau Claire, Jackson, Juneau, Marquette, Monroe, Pepin, Polk, Portage, Richland, Sawyer, Vernon, Washburn, Waushara, and Wood counties ..... Oct. 15-Sept. 1.	
Prairie chicken in Marinette and Oconto counties ..... Until Sept. 1, 1907.	
Prairie chicken in rest of State ..... Until Sept. 1, 1910.	
Turtle dove, swan	All the year.
Duck, or any aquatic fowl, except goose, brant, and swan	Jan. 1-Sept. 1.
Goose, brant	Apr. 1-Sept. 1.
Wyoming (1903-1905):	
Deer, elk, antelope, mountain sheep	Nov. 15-Sept 15.
Moose, 9 years	Until Sept. 15, 1912.
Quail, pheasant, dove, swan	All the year.
Partridge, grouse, prairie chicken (see exception)	Dec. 1-Sept. 1.
Exception: Grouse in Albany, Carbon, and Laramie counties..Oct. 15-Aug. 1.	
Sage chicken	Oct. 15-Aug. 1.
Mongolian pheasant, 5 years	Until Sept. 1, 1906.
Snipe, plover, green shank, tatler, godwit, curlew, avocet, or other wader, duck, goose, brant	May 1-Sept. 1.

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[a] On Mercer Island, Lake Washington, game animals and birds are protected all the year.

	Close seasons.
British Columbia[a] (1898–1905):	
Deer (except fawns), sheep (except ewes and lambs), goat	Dec. 15–Sept. 1.
Fawns, ewes, and lambs	All the year.
Male elk or wapiti (except in Kootenay County, to May 16, 1907), male moose, male caribou, hare	Jan. 1–Sept. 1.
Females and young of elk, moose, and caribou	All the year.
Quail, English partridge, pheasant, swan, and all game birds imported for acclimatization purposes	All the year.
Grouse, prairie chicken, ptarmigan (see exception)	Jan. 1–Sept. 1.
Exception: Grouse and ptarmigan north of 55th parallel ... Apr. 1–Sept. 15.	
Snipe, plover, duck (see exception)	Mar. 1–Sept. 1.
Exception: Duck north of 55th parallel ... Apr. 1–Sept. 15.	
Manitoba (1902–1905):	
Deer, elk or wapiti, moose, caribou or reindeer, antelope or cabri	Dec. 15–Dec. 1.
Females and young of foregoing species	All the year.
Quail, woodcock, snipe, sandpiper, plover (except upland plover)	Jan. 1–Aug. 1.
Grouse, partridge, prairie chicken	Nov. 15–Sept. 15
Dove	All the year.
Pheasant, 5 years	Until Sept. 15, 1909.
Upland plover	Jan. 1–July 1.
Duck	Jan. 1–Sept. 15.
New Brunswick (1899–1905):	
Deer, moose, caribou (cow and calf moose and cow caribou protected all the year)	Dec. 1–Sept. 15.
Partridge	Dec. 1–Sept. 16.
Pheasant	All the year.
Woodcock, snipe, teal, wood duck, dusky or black duck, goose, brant	Dec. 2–Sept. 1.
Shore or other birds on beaches, islands, or lagoons bordering tidal waters of Northumberland Strait, Gulf of St. Lawrence, and Bay of Chaleur	Jan. 1–Sept. 1
Newfoundland[b] (1902–1904):	
Elk, moose, 10 years	Until Jan. 1, 1912.
Caribou	Feb. 1–Oct. 21.[c]
Ptarmigan, willow grouse or partridge, any grouse	Jan. 12–Oct. 1.
Snipe, plover, curlew, or "other wild or migratory birds (except wild geese)"	Jan. 12–Aug. 21.
Northwest Territories[d] (1903):	
Deer, elk, moose, caribou (females and young protected all the year)	Dec. 15–Nov. 1.
Antelope	Nov. 15–Oct. 1.
Buffalo	All the year.
Mountain sheep, mountain goat (females and young protected all the year)	Dec. 15–Oct. 1.
Big game in SE. Assiniboia (females and young protected all the year)	Dec. 15–Dec. 1.
Grouse, partridge, prairie chicken, pheasant, ptarmigan	Dec. 15–Sept. 15.
Crane	Jan. 1–Aug. 1.
Snipe, sandpiper, plover, curlew, shore birds, rail, coot, duck	May 5–Aug. 23.
Nova Scotia (1900–1905):	
Deer, caribou, 5 years	Until Oct. 1, 1910.
Moose (see exceptions)	Jan. 2–Oct. 1.
Exceptions: On Island of Cape Breton, until Oct. 1, 1915. Calf moose under 1 year	All the year.
Hare, rabbit	Mar. 1–Nov. 1.
Ruffed grouse or partridge	Dec. 2–Oct. 1.

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[a] The lieutenant-governor is empowered to make further restrictions in these seasons. Resident Indians (nonresidents not allowed to hunt) and farmers in "unorganized districts" may kill deer for immediate use as food, but Indians can kill doe and fawn only Aug. 1–Feb. 1; free miners while engaged in placer mining or prospecting in unorganized districts, and surveying or engineering parties engaged in their duties may kill any game for food. By proclamation of March 31, 1904, the lieutenant-governor in council declared that "all that portion of the Province not included within any municipality, except the Kamloops, Okanagan, Similkameen, Greenwood, and Grand Forks Electoral Districts, shall be defined as an unorganized district within the meaning of the 'Game Protection Act, 1898.'"

[b] Stipendiary magistrates may in their respective districts prohibit destruction of hares and rabbits for specified terms.

[c] Except Aug. 1–Oct. 1.

[d] Lieutenant-governor may regulate close seasons for introduced game birds.

Nova Scotia (1900-1905)—Continued.	*Close seasons.*
Spruce partridge, sharp-tailed grouse, ptarmigan, blackcock, capercailzie, chukar partridge, pheasant	All the year.
Woodcock, snipe, teal, blue-winged duck, wood duck (see exception)	Mar. 1-Aug. 20.
Exception:—Cumberland Co. (blue-winged duck)	May 1-Sept. 1.
Ontario[a] (1900-1905):	
Deer (young protected all the year)	Nov. 16-Nov. 1.[b]
Elk or wapiti	All the year.
Moose, caribou or reindeer (except as below)	Nov. 16-Oct. 16.[c]
Female moose and young moose and caribou	All the year.
Squirrel (black or gray)	Dec. 16-Sept. 15.
Hare[d]	Jan. 1-Oct. 1.
Quail, wild turkey	Dec. 1-Nov. 1.
Grouse, woodcock, snipe, plover, rail, other "shore" birds or "waders"	Dec. 16-Sept. 15.
Prairie fowl, pheasants (English, Mongolian), 5 years	Until Sept. 15, 1910.
Capercailzie	Until Sept. 15, 1909.
Dove	All the year.[e]
Goose, swan	May 1-Sept. 15.
Ducks and other "waterfowl" (except geese and swans)	Dec. 16-Sept. 1.
Prince Edward Island (1890):	
Hare, rabbit	Mar. 1-Sept. 1.
Partridge	Dec. 1-Oct. 1.
Woodcock, snipe	Jan. 1-Aug. 20.
Duck	Mar. 1-Aug. 25.
Quebec (1899-1903):	
Zone 1.[f] Deer, moose (see exceptions)	Jan. 1-Sept. 1.
Exceptions: In Ottawa and Pontiac counties	Dec. 1-Oct. 1.
Cow moose and young deer and moose	All the year.
Caribou (young protected all the year)	Feb. 1-Sept. 1.
Hare	Feb. 1-Nov. 1.
Bear	July 1-Aug. 20.
Birch or swamp partridge	Dec. 15-Sept. 1.
White partridge or ptarmigan	Feb. 1-Nov. 1.
Woodcock, snipe, sandpiper, plover, tatler, curlew	Feb. 1-Sept. 1.
Widgeon, teal, duck (except sheldrake and except east and north of counties of Bellechasse and Montmorency, June 1-Aug. 1)	Mar. 1-Sept. 1.
Zone 2. Close seasons same as in Zone 1, except as follows:	
Caribou	Mar. 1-Sept. 1.
Hare	Mar. 1-Oct. 15.
Birch or swamp partridge	Feb. 1-Sept. 15.
White partridge or ptarmigan	Mar. 1-Nov. 15.
Unorganized Territories[g] (Keewatin, etc.), 1894:	
Deer, elk or wapiti, moose, caribou, mountain sheep, mountain goat	Apr. 1-Dec. 1.[h]
Musk ox	Mar. 20-Oct. 15.
Grouse, partridge, prairie chicken, pheasant	Jan. 1-Sept. 1.
Duck, goose, swan	Jan. 15-Sept. 1.
Yukon[i] (1901):	
Deer, elk or wapiti, moose, caribou, mountain sheep, mountain goat, musk ox	Jan. 1-Oct. 1.
Bison or buffalo	All the year.
Grouse, partridge, prairie chicken, ptarmigan, pheasant	Jan. 15-Oct. 1.
Snipe, sandpiper, crane, duck, goose, swan	June 1-Sept. 1.

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[a] Lieutenant-governor in council may alter close seasons in region north and west of French River, Lake Nipissing, and Mattawa River, and close for a definite period seasons for any game animal or nonmigratory game bird whose numbers have diminished.

[b] Persons who put or breed deer on their own lands, and their licensees, may hunt such deer Oct. 1-Nov. 16.

[c] South of the Canadian Pacific R. R. between Mattawa and the Manitoba boundary, Nov. 16-Nov. 1.

[d] Cottontail rabbits (wood hares) may be killed during close season by other means than shooting.

[e] Under act for protection of insectivorous birds, Rev. Stats. 1897, chap. 289, sec. 3.

[f] Zone No. 1 comprises the whole Province, except that part of the counties of Chicoutimi and Saguenay east and north of the river Saguenay. Zone No. 2 comprises the part of said counties east and north of the Saguenay.

[g] Indians, inhabitants, and travelers, explorers, and surveyors in need of food exempt. Governor in council may alter seasons.

[h] Except July 15-Oct. 1.

[i] Indians, explorers, surveyors, prospectors, miners, and travelers in need of food are exempt. Commissioner in council may alter seasons.

SHIPMENT OF GAME.

Shipment is one of the most important subjects of game legislation, since it is one of the principal features of the trade in game. It may be considered under the following subheads: "Federal laws," "Marking packages," and "State laws prohibiting export."

FEDERAL LAWS.

Federal laws for the protection of game comprise the statutes regulating interstate commerce in game and the importation of birds from foreign countries, and those providing for the protection of birds and game on territory under the immediate jurisdiction of the United States.

They comprise: (1) The Lacey Act, regulating the importation of game and its shipment from one State to another; (2) the tariff act, imposing duties on game, skins, and feathers imported from foreign countries; (3) the act regulating the introduction of eggs of game birds; (4) game laws of the District of Columbia, Alaska, and the Indian Territory, and (5) provisions for protecting birds in the national parks,[a] forest reserves, and other Government reservations. These laws are more fully discussed in Bulletin No. 16 of the Biological Survey, entitled "Digest of Game Laws for 1901" (pp. 69–79). The full text of several may be found in various circulars published by the Biological Survey: Circular No. 29 (1900) contains the Lacey Act, Circular No. 34 (1901), the game laws of the District of Columbia, and Circular No. 42 (1904), the Alaska game law, with regulations for 1904.

MARKING PACKAGES.

Section 4 of the Lacey Act requires every package containing game animals or birds when shipped by interstate commerce to be clearly marked so as to show the name and address of the shipper and the nature of the contents. The laws of Colorado, Connecticut, Louisiana, Michigan, Montana, Nebraska, North Carolina, Ohio, Oregon, Wisconsin, New Brunswick, and Ontario likewise require each package of fish or game to bear a statement indicating the contents. Such general statements as "game" or "birds" are not sufficient to show the nature of the contents; the *kind* of game should be shown, and also, if possible, the *amount* in the package.

Some of the State laws are very explicit on the subject of marking. Nebraska requires that all packages shall be labeled with the address of the consignor and the amount of each kind of game contained in the package, and provides a fine of $10 to $50 for omission of these details. Ohio has similar requirements. Michigan requires that all packages of game shall be plainly marked on the outside with the names of the consignor and consignee, the initial point of billing and destination, and an itemized statement of the quantity of game contained therein. Louisiana and Ontario insist that all packages, besides bearing a description of the contents and the names and addresses of owners, must be so made as to *show the contents.* Several States require big game and game birds carried by sportsmen to be marked with the owner's name, shipped as baggage, and transported open to view.

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[a] The law governing the Yellowstone Park prohibits any person, or any stage, express, or railway company from receiving for transportation animals, birds, or fish taken in the park, under a penalty not exceeding $300 (28 Stat. L., chap. 72, sec. 4).

Railroad and express companies should call the attention of their agents to these provisions, and insist that all packages be properly marked before shipment. In Nebraska common carriers are prohibited, under a penalty of $25 to $100, from receiving consignments of game not properly labeled. In Texas they may examine suspected packages, and in Arkansas they may cause them to be opened when necessary, and may refuse packages supposed to contain fish or game for export. In Wisconsin packages of fish or game not properly marked may be seized and sold by game wardens.

STATE LAWS PROHIBITING EXPORT.

Since the constitutionality of the Connecticut statute prohibiting export of certain game was established by the Supreme Court in 1896[a] nonexport laws have been generally adopted, and at the present time nearly every State prohibits the export of certain kinds of game. (See fig. 3, p. 35.) Mississippi seems to have no such laws. In some States sportsmen are allowed to carry a limited amount of game out of the State under special restrictions, and exceptions to the laws prohibiting export are also made in the case of birds and animals intended for propagation.

Restrictions on shipment from the State have now become so stringent that all the States and Territories west of the Mississippi River except two prohibit export of all game protected by local laws. Of the two exceptions, Iowa prohibits export of all game but shore birds, and Wyoming export of certain species. East of the Mississippi similar laws are in force in nearly all of the States north of the Ohio and Potomac rivers, and also in Tennessee, Virginia, and West Virginia. The export of most if not all protected game taken within the State is prohibited in all these States except Massachusetts, Rhode Island, Connecticut, New Jersey, Delaware, Maryland, Illinois, and Indiana, and in these export of certain kinds of game is illegal.

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[a] Geer *v.* Connecticut, 161 U. S., 519.

Deer can be lawfully exported from only seven States—Delaware (where they do not occur), Alabama, Georgia, Kentucky, Mississippi, North Carolina, and Ohio. The export of deer hides is prohibited by pecial provisions in the laws of Alaska, California, Florida, Wyoning, British Columbia, and Ontario; Wisconsin limits the export of reen hides to the period from November 13 to December 3 of each ear; Washington and British Columbia prohibit killing deer for ides; Oregon makes all hunting for hides dependent on permission of he State game and forestry warden; and New Brunswick and Newoundland allow shipment of green hides only under license.

Among game birds the most general prohibition is that of the xport of quail, which is now in force in every State and Territory, ith three exceptions. In one of the excepted States, Wyoming, quail o not occur; in another, Maryland, several counties prohibit their xport; and another, Mississippi, does not prohibit the export of any ame. A number of States permit imported birds to be exported, owever, and Colorado, Illinois, Missouri, Montana, and Manitoba llow quail to be shipped from the State under permit. Besides these xceptions, 23 States, including Oregon, permit nonresident hunters to ke a limited number of birds out of the State; Maine, Missouri, Monna, South Dakota, Vermont, Virginia, Wyoming, British Columbia, nd New Brunswick grant the same privilege to resident hunters.

Special attention is called to the following table, which contains a st of the game prohibited from export by each State and Territory:

Export of game prohibited by State laws.

labama:[a]

Deer, squirrel, quail, partridge, grouse, prairie chicken, pheasant, English, Mongolian, or Chinese pheasant, wild turkey, woodcock.

laska:

Deer, moose, caribou, mountain sheep, mountain goat, wild birds, or any parts thereof.

Exception: Specimens and trophies may be exported under restrictions imposed by the Secretary of Agriculture.[b]

rizona:

Deer, elk, antelope, sheep, goat, quail, bobwhite, partridge, grouse, pheasant, wild turkey, snipe, rail, duck, goose, brant.

rkansas:

Game of any kind.

alifornia:

Deer, deerskins, quail, partridge, grouse, prairie chicken, sage hen, pheasant, dove, wild pigeon, shore birds, plover, snipe, rail, curlew, ibis, duck.

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[a] Applicable only to Houston, Madison, and Perry counties. The following county laws are in rce:

Bullock.—Quail, wild turkey, dove (if taken in county).
Dallas.—Deer, quail, wild turkey, dove, unless accompanied by owner or intended for his use.
Etowah.—Deer, quail, wild turkey, pheasant, dove.
Hale.—Quail, for sale.
Houston.—Quail, dove, snipe, woodcock.
Lamar, Shelby, Tuscaloosa.—Deer, quail, wild turkey, dove.
Macon.—Squirrel, opossum, quail, wild turkey, dove.
Madison, Perry.—Deer, squirrel, quail, grouse, pheasant (including English and Mongolian or Chinese pheasants), prairie chicken, wild turkey, dove, woodcock from State.
Sumter.—Quail, dove.
Talladega.—Quail, for sale (if taken within county).

[b] See circular No. 42, Biological Survey, U. S. Department of Agriculture, 1904.

Colorado:

Deer, elk, antelope, bison, buffalo, sheep, quail, partridge, grouse, ptarmigan, prairie chicken, sage chicken, pheasant, wild turkey, dove, pigeon, snipe, curlew, crane, duck, goose, brant, swan, waterfowl.

Exception: Game may be exported under permit from game commissioner if permit be attached and package plainly marked so as to show nature of contents. The following fees are charged for export permits: Elk, $10; deer, $5; antelope, $5.

Connecticut:

Quail, ruffed grouse, woodcock.

Delaware:

Rabbit, quail, partridge, woodcock (nonresidents also prohibited from shipping Wilson or English snipe).

Florida:

Deer, deer hides, quail or partridge, wild turkey from county.

Georgia:

Quail or partridge.

Idaho:

Deer, elk, moose, caribou, antelope, buffalo, mountain sheep, mountain goat, quail, partridge, grouse, prairie chicken, sage hen, Mongolian pheasant, dove, plover, snipe, duck, goose, swan.

Exception: Nonresidents may export, under hunting license, animals lawfully taken: but each shipment must be accompanied by a sworn statement of number and date of license and fact that game was not procured contrary to law.

Illinois:

Squirrel, quail, ruffed grouse, pinnated grouse, prairie chicken, pheasant, wild turkey, duck, goose, brant, taken within the State.

Exception: Game may be exported under license from the State; nonresident may take from State 50 birds killed by himself, if carried openly for inspection.

Indiana:

Deer, quail, grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant, or any waterfowl.

Exception: Nonresident may take from State 24 birds killed by himself, if carried openly for inspection, together with his license.

Indian Territory:

"Every person other than an Indian who hunts, traps, takes, or destroys any game *except for subsistence in the Indian country*, shall forfeit all traps, guns, and ammunition in his possession, and shall be liable in addition to a penalty of $500." (Rev. Stat. U. S., 1878, sec. 2137.)

Iowa:

Squirrel, quail, ruffed grouse, pinnated grouse, prairie chicken, pheasant, wild turkey, woodcock, duck, goose, brant.

Exception: Nonresident may take from State not more than 25 game birds or animals killed by himself, if carried openly for inspection.

Kansas:

Quail, partridge, grouse, prairie chicken, pheasant, dove, plover, duck, goose, brant.

Kentucky:

Quail, partridge, grouse, pheasant, wild turkey killed within the State.

Louisiana:

Deer, squirrel, quail, prairie chicken, wild turkey, dove, grosbec, woodcock, snipe, surf bird, chorook, sandpiper, plover, tatler, curlew, papabotte (upland plover), rail (mud hen), gallinule, coot (poule d'eau), duck, goose, brant, swan, taken within the State.

Exception: A sportsman may carry with him out of the State 1 deer and 12 birds of each kind.

Maine:

Deer, moose, quail, ruffed grouse, pheasant, capercailzie or cock of the woods, black game, plover, woodcock, snipe, sandpiper, wood duck, dusky or black duck, teal, gadwall or gray duck, mallard, widgeon or baldpate, shoveler, pintail or sprigtail, redhead, scaup or greater bluebill, lesser scaup or lesser bluebill, golden eye or whistler, buffle head, ruddy duck or broadbill.

Exceptions: Anyone may export birds in open season not exceeding 15 of a kind at one time, if tagged, open to view, showing name and address of owner and accompanied by him; and a resident of the State may export 2 deer in a season under same restrictions. Nonresident may export under hunting license 1 moose and 2 deer lawfully killed by himself; may take to his home 10 partridges, 10 ducks, and 10 woodcock additional and may ship to his home 1 pair of game birds at any time under shipping license. Resident may export under shipping license 1 moose lawfully killed by himself.

Maryland:

Allegany—Quail, pheasant, wild turkey, woodcock.

Anne Arundel—Squirrel, rabbit, quail, partridge, pheasant, woodcock, snipe, plover, dead or alive, from county.

Maryland—Continued.

Baltimore—Partridge, pheasant, woodcock.

Calvert—Rabbit, partridge, woodcock from county (for sale, barter, or trade).

Caroline—Rabbit, quail, partridge, woodcock from county.

Dorchester—Squirrel, rabbit, quail, partridge, woodcock.

Exception: Any person may take out of county as personal baggage 18 quail or partridges 6 squirrels, rabbits, or woodcock, if carried openly.

Frederick—Squirrel, partridge, pheasant, woodcock from county.

Kent—Squirrel, rabbit, or any bird from county (for sale, except under license).

Montgomery—Partridge, pheasant, wild turkey from county (for sale).

Queen Anne—Rabbit, partridge, woodcock from county (for sale).

Somerset—Squirrel, rabbit, partridge, pheasant, dove, woodcock, duck, goose from county.

Washington—Deer, squirrel, rabbit, partridge, pheasant, wild turkey from county (for sale).

Wicomico and Worcester—Quail or partridge from both counties considered as one territory.

Massachusetts:

Quail, ruffed grouse, woodcock taken in the State; any other game illegally taken or killed within the State

Michigan:

Deer, elk, moose, caribou, squirrel, quail, partridge, ruffed grouse, prairie chicken, spruce hen Manitoba grouse, ptarmigan, Mongolian or English pheasant, wild turkey, dove, pigeon, snipe, plover, woodcock, duck, goose, brant, or other wild waterfowl.

Exceptions: (1) Game consigned to point within the State may be transported without the State if necessary to reach destination.

(2) Nonresident licensee may take 1 deer out of the State under permit from State game and fish warden.

(3) Landowners and members of clubs that own and maintain game preserves may ship during open season under a $10 permit from State game and fish warden 50 wild ducks or other migratory birds lawfully killed by them on their own premises.

Minnesota:

Deer, elk, moose, caribou, hide or horns thereof, quail, partridge, ruffed grouse, prairie chicken, pinnated grouse, sharp-tailed or white-breasted grouse, ring-neck or English or Chinese pheasant, dove, snipe, wild duck, goose, brant, or any aquatic fowl.

Exception: Nonresident licensee may ship, under his license coupons, to his residence, during the time when possession is lawful, 1 deer and 25 birds lawfully taken by himself.

Missouri:

Deer, squirrel, quail, pinnated grouse, prairie chicken, ruffed grouse, pheasant, wild turkey, dove, woodcock, snipe, plover, duck, goose.

Exception: Game lawfully killed may be taken out of the State under resident or nonresident hunting license, if carried in personal possession or openly as baggage or express by the owner and accompanied by him on the same train. State game and fish warden may issue a permit to any person to take out of the State any bird or game to be used exclusively for scientific or propagating purposes.

Montana:

Deer, elk, moose, buffalo, mountain sheep, mountain goat, quail, pheasant or partridge, prairie chicken, fool hen, sage hen, grouse, Chinese pheasant, duck, goose, brant, swan.

Exception: Game lawfully killed may be exported from the State during the open season if accompanied by the owner, and when shipped by resident of State, by permit from State game and fish warden, or when shipped by nonresident of State, by hunting license; total shipment under one license not to exceed number allowed to be killed in one season; all packages to be plainly labeled so as to show nature of contents.

Nebraska:

Deer, elk, antelope, quail, partridge, pheasant, grouse, ptarmigan, prairie chicken, sage chicken, wild turkey, pigeon, dove, snipe, plover, yellow-legs, curlew, crane, duck, goose, brant, swan.

Exception: Nonresident may ship 50 birds out of State under hunting license, but must give common carrier invoice of number and kind of birds and have details of shipment marked on license, and must accompany the shipment.

Nevada:

Deer, elk, antelope, caribou, mountain sheep, mountain goat, quail, grouse, pheasant, sage chicken, prairie chicken, dove, snipe, plover, woodcock, curlew, sand-hill crane, duck, goose.

New Hampshire:[a]

Elk, moose, caribou, quail, partridge, ruffed grouse, pheasant, woodcock, Wilson snipe, dove, plover, yellow-legs, sandpiper, rail, duck (except sheldrake), and all "beach" birds.

Exception: Nonresident may export under his hunting license 12 birds, carried open to view, on notice to commissioner who issued the license, of number and kind.

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[a] Blue Mountain Forest Association permitted to ship deer, elk, and moose killed in its preserve.

New Jersey:

Hare, rabbit, squirrel, quail or partridge, ruffed grouse or pheasant, pinnated grouse, English pheasant, ring-neck pheasant, woodcock.

Exception: English or ring-neck pheasants killed on preserves established prior to April 15, 1903, may be exported from the State.

New Mexico:

Deer, elk, antelope, mountain sheep, native or crested quail, bobwhite quail, partridge, mountain grouse, prairie chicken, pheasant, ptarmigan, wild turkey, turtle dove, wild pigeon for market.

New York:

Game or birds taken in the State, including deer (excepting head, feet, and skin), elk, antelope, moose, caribou, squirrel, hare, rabbit, quail, grouse, Mongolian and English pheasants, plover, Wilson and English snipe, woodcock, curlew, shore birds, rail, mud hen, gallinule, water chicken, duck, goose, brant, or swan.

North Carolina:[a]

Quail, partridge, pheasant, wild turkey, snipe, woodcock, taken in State.

Exception: Nonresident may take out of State under his hunting license 50 quail (partridges) in a season.

North Dakota:

Deer, elk, moose, caribou, antelope, buffalo, mountain sheep, quail, ruffed grouse, prairie chicken, pinnated grouse, sharp-tailed grouse, English or Chinese pheasant, woodcock, crane, duck, goose, brant, swan.

Ohio:

Squirrel, quail, ruffed grouse or pheasant, Mongolian pheasant, English or ring-neck pheasant, dove, woodcock, plover, snipe, shore birds, rail, duck, goose, swan, coot, mud hen.

Exception: Nonresident may take with him from State under his hunting license 50 animals and birds.

Oklahoma:

Deer, antelope, quail, grouse, prairie chicken, imported pheasant, wild turkey, dove, plover.

Oregon:

Deer, antelope, elk, moose, mountain sheep (or hides of said animals), quail or bobwhite, English or gray partridge, capercailzie, moor hen, grouse, sage hen, pheasant, Mongolian, silver, golden, copper, green Japanese, and Reeves pheasants, prairie chicken, wild turkey, woodcock, rail, upland plover, duck, goose, swan, or other wild fowl.

Exception: Any citizen of Washington may take one day's bag with him out of the State.

Pennsylvania:

Deer, rabbit, hare, squirrel, quail, partridge, grouse, pheasant, English, Mongolian, or Chinese pheasant, wild turkey, reedbird, plover, woodcock, rail, web footed wild fowl taken in State.

Rhode Island:

Quail, ruffed grouse, woodcock.

South Carolina:

Deer, quail or partridge, wild turkey for sale (until 1908).

South Dakota:

Deer, elk, antelope, buffalo, mountain sheep, quail, ruffed grouse, prairie chicken, pinnated grouse, sharp-tailed grouse, plover, curlew, woodcock, crane, duck, goose, brant.

Exception: Two deer, 1 elk, 1 buffalo, 1 mountain sheep, and not more than 15 birds not intended for commercial purposes may be shipped in open view during open season and 3 days thereafter, when tagged and accompanied by owner; and, in the case of big game, a certificate—good for 5 days—that such game was lawfully killed must be obtained from a justice of the peace and given to the carrier.

Tennessee:

All State game, viz: Deer, squirrel, quail, partridge, grouse, prairie chicken, pheasant, wild turkey, marsh blackbird, dove, meadowlark, robin, plover, snipe, woodcock, sandpiper, tatler, willet, curlew, godwit, avocet, rail, coot, mud hen, duck, goose, swan, brant.

Exception: Nonresident may take his game with him from the State, but must present to some officer or employee of common carrier his hunting license and sworn statement that his game is not for sale and will not be sold.

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[a] The following county laws are also in force:

Anson—Partridge, for profit, from county.
Catawba—Quail, dead or alive, from county.
Cherokee—Quail, partridge, pheasant, wild turkey, dove, snipe, woodcock, robin.
Cleveland —Partridge, for profit, from county.
Currituck—Wild fowl, April 1 to November 1.
Henderson—Birds, game, or wild fowl.
Iredell—Quail, dead or alive, from county.
Lenoir —Quail, partridge for sale, f om county.
Madison—Quail or partridge.
Rowan—Quail, partridge, grouse, pheasant, wild turkey, dove, woodcock from county.
Surry—Quail from county.
Swain—Quail, alive, from county.
Union—Quail, partridge, robin from county.
Yancey—Quail, partridge from county.

Texas:

All wild animals, wild birds, and wild fowl found within State, including, deer, antelope, mountain sheep, quail or partridge, grouse, pinnated grouse or prairie chicken, Mongolian or English pheasant, wild turkey, dove, pigeon, plover, snipe, jacksnipe, curlew, duck, goose.

Utah:

Deer, elk, antelope, mountain sheep, quail, partridge, prairie chicken, sage hen or grouse, pinnated grouse, pheasant, Mongolian, Chinese, or English pheasant, dove, snipe, shore bird, duck, goose brant, swan, or any introduced game animal or bird.

Vermont:

Deer, gray squirrel, quail, ruffed grouse or partridge, plover, English snipe, woodcock, wild duck, wild goose.

Exception: One deer may be exported during the open season and ten days thereafter by a resident, if shipped open to view, properly labeled with the name of the owner and accompanied by him; and by a nonresident when his license, with shipping coupons attached, is presented to the transportation company.

Virginia:

Deer, venison, quail or partridge, pheasant or grouse, wild turkey, woodcock, plover, snipe, sandpiper, surf bird, curlew, willet, tatler, rail (except sora), mud hen, gallinule, waterfowl.

Exceptions: During open season nonresident may, under his hunting license, take with him out of the State, or as baggage on the same conveyance, 1 deer, 50 quail or partridges, 10 pheasants or grouse, 3 wild turkeys, 30 waterfowl, and 25 of each, or 100 in all, of plover, snipe, sandpipers, willets, tatlers, and curlew, if killed or captured by himself, and shipped open to view and plainly labeled with his name and address. Any citizen of State may ship from the State, as a gift and not for sale (which fact must be stated on shipping tag), 1 deer, 18 quail or partridges, 6 pheasants, 3 wild turkeys, and 12 waterfowl, if open to view and plainly labeled with names and addresses of donor and donee, and number of each kind of bird so shipped.

Washington:

Deer, elk, moose, caribou, antelope, mountain sheep or goat, quail, partridge, grouse, prairie chicken, sage hen, pheasant, ptarmigan, plover, rail, sandhill crane, snipe, duck, swan, goose, brant, or any other game animal or bird of the State, including introduced bobwhite, California valley quail, mountain quail, and Old World pheasants.

Exception: Nonresident may export one season's limit of big game and one day's bag limit of birds under his hunting license, if accompanied by affidavit that the game was killed by him and is not for sale.

West Virginia:

Deer, quail, pheasant, ruffed grouse, wild turkey.

Wisconsin:

Deer, quail, partridge, grouse, prairie chicken, pheasant, Mongolian, Chinese, or English pheasant, dove, plover, snipe, woodcock, wild duck, goose, brant, or other aquatic fowl.

Exception: During open season nonresident may take out of State under his hunting license, in personal possession or as baggage or express, accompanying same to State line, 2 deer, and not more than 50 game animals and birds of all kinds, provided packages are plainly marked so as to show the names and addresses of shipper and consignee, and number of each kind of game, and, in case of deer, have proper coupons attached.

Wyoming:

Deer, elk, moose, antelope, mountain sheep, or green hides, teeth, or horns of any of said animals.

Exceptions: Smithsonian Institution or other well-known scientific institutions may export any game animals or birds, under permit of State game warden; mounted heads and stuffed specimens may be shipped out of State

Export of 1 hide, 1 scalp, 1 head, and 1 pair of tusks of any big game except moose, permitted upon affidavit that they were taken from animals lawfully killed and the payment of 25 cents to the justice of the peace of precinct where affiant lives and attachment of the tag issued by him; and a nonresident (or resident, when necessary to cross territory of another State to reach his home), may export under his hunting license carcasses, heads, antlers, scalps, skins, and teeth of any animals lawfully killed.

British Columbia:

Deer, elk, moose, caribou, mountain sheep, mountain goat, hare, quail, partridge (English), pheasant, grouse, prairie chicken, ptarmigan, snipe, plover, duck, swan.

Exception: Heads, horns, and skins of big game lawfully killed by the shipper may be shipped under his hunting license.

Manitoba:

Deer, elk, moose, caribou, antelope, quail, grouse, partridge, prairie chicken, pheasant, plover, snipe, sandpiper, woodcock, duck.

Exception: Minister of agriculture and immigration may issue permit to export game, except grouse, prairie chicken, and partridge, and not more than 100 geese and swans, or 50 ducks.

New Brunswick:[a]

Deer, moose, caribou, or any portion thereof; partridge, pheasant, woodcock, snipe, wood duck, dusky (black) duck, teal, goose, brant.

Exception: Surveyor-general may issue special license to export game alive or dead.

Newfoundland:

Caribou, willow or other grouse for sale.

Exceptions: Minister of marine and fisheries may issue special license to export game for breeding or scientific purposes. Nonresident may export 3 stag caribou under hunting license and export permit; resident may export antlers, head, or skin of caribou under export permit; but not, in either case, for sale.

Northwest Territories:

Deer, elk, moose, caribou, buffalo, sheep, goat, antelope, grouse, prairie chicken, pheasant, ptmarigan, snipe, sandpiper, plover, curlew, any shore bird, rail, coot, crane, duck.

Exception: The holder of a general nonresident license may take with him out of Territories as trophies heads, skins, and hoofs of big game legally killed by him.

Nova Scotia:

Red deer, elk, moose, caribou, hare, rabbit, Canada grouse (spruce partridge), ruffed grouse (birch partridge), pheasant, blackcock, capercailzie, ptarmigan, sharp-tailed grouse, woodcock, snipe, blue-winged duck, teal, wood duck.

Exceptions: Holder of general license may take with him, out of Province, any moose and caribou lawfully shot by himself; and 2 mounted heads and dressed skins of each kind may be exported under permit from provincial secretary.

Ontario:

Any wild game animal or bird.

Exception: 1 bull moose and 1 bull caribou or head, skin, or parts thereof, between October 15 and December 1, and 2 deer, head, skin or part thereof in November, and 100 ducks may be exported under nonresident hunting license, if shipping coupon and, if required, affidavit of lawful killing be attached, and contents of packages be open to view.

Canada also has a general law prohibiting export of deer, wild turkeys, quail, partridges, prairie fowl, and woodcock, but making exception in the case of deer raised on private preserves and permitting each nonresident to export two deer in a year at certain ports within fifteen days after the close of the open season, under permit of the collector of customs of the port from which export is made. The ports of export are: Halifax and Yarmouth, Nova Scotia; Macadam Junction, New Brunswick; Quebec, Montreal, and Ottawa, Quebec; Kingston, Niagara Falls, Fort Erie, Windsor, Sault Ste. Marie, and Port Arthur, Ontario; and such others as the minister of customs may designate.

Those who visit Canada to hunt, camp, etc., must deposit with the customs officer at the port of entry an amount equal to the duty (30 per cent of appraised value) on their guns, canoes, tents, cooking utensils, and kodaks. If these articles are taken out within six months at the same port, the deposit will be returned. But members of shooting or fishing clubs that own preserves in Canada and have filed a guaranty with the Canadian commissioner of customs may present club membership certificates in lieu of making the deposit. They must, however, pay duty on all ammunition and provisions.

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[a] Except in the case of partridge the prohibition applies only to common carriers.

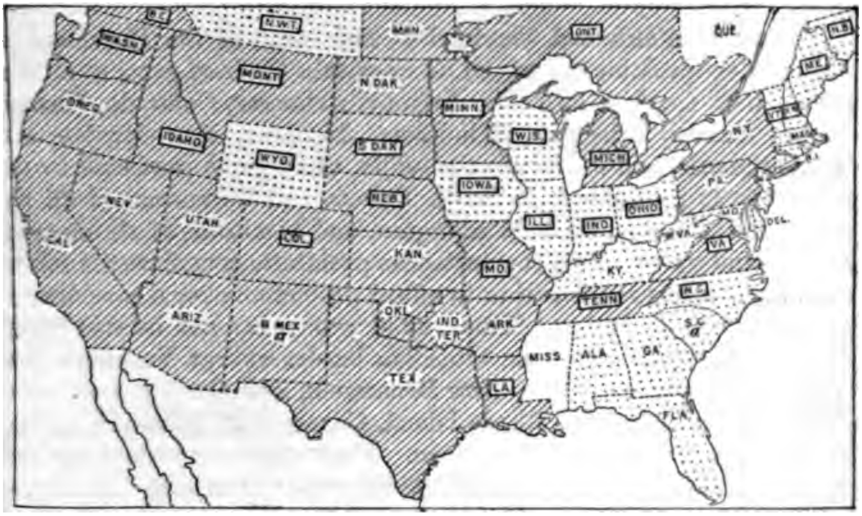

Fig. 3.—States and Provinces which prohibit export of game. Ruled areas indicate States which prohibit export of any game; dotted areas, States which prohibit export of certain kinds of game; blank areas, States which do not prohibit export. Enclosed names indicate special exceptions permitting nonresident hunters to take out a limited amount of game. The letter *a* indicates prohibition of export for sale only. (For details, see pp. 28-31.)

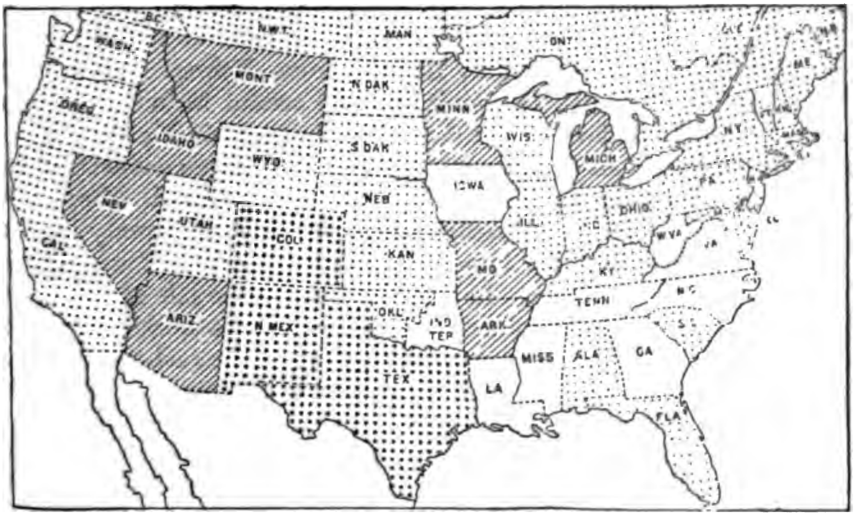

Fig. 4.—States and Provinces which prohibit sale of game throughout the year. Ruled areas indicate States prohibiting sale (resale in Nevada) of all protected game; crossed areas, States prohibiting sale of all protected game taken within the State; dotted areas, States prohibiting sale (resale in Delaware) of certain game; and blank areas, States that have no sale prohibitions (except a few local provisions in North Carolina and Virginia). (For details, see pp. 36-40.)

MAPS SHOWING RESTRICTIONS ON EXPORT AND SALE.

SALE.

Forty-two States and Territories[a] and most of the Provinces of Canada now prohibit the sale of all or certain kinds of game at all seasons. (See fig. 4, p. 35.) In Arizona, Arkansas, Colorado, Hawaii, Idaho, Kansas, Michigan, Minnesota, Montana, New Mexico, and Texas the sale, and in Nevada the resale, of all game protected by the State law is prohibited; in South Dakota and Wisconsin, of all big game; in California, Utah, Washington, and Manitoba, of all big game and upland game. In a few instances prohibitions against the sale of certain game are so general as to afford protection over a considerable area in adjoining States. Thus, ruffed grouse can not be sold in any State or Province along the Canadian border except Vermont, New York, Pennsylvania, Ohio, New Brunswick, and Quebec, nor in the States of Massachusetts, Rhode Island, Connecticut, Missouri, Arkansas, Kansas, Nebraska, or Wisconsin. Practically every State in which prairie chickens occur now prohibits their sale or export. Hence the exposure for sale of these birds in any State where they do not occur, as in any city east of Indianapolis, is strong indication of violation of law.

As a rule, the sale of game is prohibited during the close season, but is often permitted during the open season for hunting. Sometimes a brief additional open period is provided in order to permit dealers to close out such stock as they have on hand at the end of the hunting season. In Colorado, Illinois, Iowa, Nebraska, New York, Tennessee, and British Columbia the sale season includes the open season and the following five days for all or certain kinds of game. An extension of four days for sale is added to the open season in Nova Scotia; ten days in New Brunswick and Newfoundland; fifteen days in Alaska, New Jersey, Pennsylvania, and Quebec; twenty days in Ontario; thirty days (for imported ruffed grouse) in Pennsylvania; and sixty days in Yukon. In New Brunswick the sale of goose and brant is permitted during the open season and three months later, and in Massachusetts dealers or persons engaged in the cold-storage business are permitted to sell quail until May 1, five months (four and a half months in Bristol County) after the close of the open season.

In order to counteract a tendency on the part of market hunters to anticipate the opening of the hunting season, one State and two Provinces have prohibited the sale of certain game at the beginning of the open season, the first two days in Illinois, the first three in Nova Scotia, and the first month in British Columbia. Washington permits the sale of snipe and wild fowl (which may be killed from September 1 to

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[a] Including Hawaii, but omitting North Carolina, Tennessee, and Virginia, which prohibit sale in only a few of their counties.

March 1) only during November and to the number of not more than 25 in a day.

The following table shows the species sale of which is prohibited:

List of game sale of which is prohibited.

Alabama:

Bullock—Wild turkey, dove, except November 1-March 16.

Houston, Madison, Perry—Deer, squirrel, quail, partridge, grouse, pheasant, wild turkey, woodcock, killed or trapped within the State. (State law.)

Calhoun, Macon, Talladega—Quail.

Dallas—Deer, quail, wild turkey, dove.

Hale—Quail, taken in county.

Russell—Quail, wild turkey, dove.

Sumter—Deer, quail, wild turkey, dove, for export from county.

Alaska:

Heads, hides, and skins of all protected game; carcasses of all game except during open season and 15 days thereafter.

Arizona:

Deer, elk, antelope, sheep, goat (or meat, hide, head, or horns, of said animals), quail, bobwhite, partridge, grouse, pheasant, wild turkey, dove, snipe, rail, duck, goose, brant.

Arkansas:

All "game, wild fowl, or birds whatsoever," except bears, rabbits, and squirrels.

California:

Deer meat and hides of female deer or those from which evidence of sex has been removed, quail, partridge, grouse, pheasant, sage hen, dove, ibis, snipe, plover, rail, or shorebirds.

Colorado:

All game taken in the State except that domestic game may be sold by hotels, restaurants, etc., during the open season and five days thereafter, or during the limits of a storage permit. Imported game and game taken from licensed private parks and lakes may be sold at any time if accompanied by an invoice. For sale of imported game a license is also necessary.

Connecticut:

Quail, ruffed grouse, woodcock, until October 1, 1907.

Delaware:

Quail, partridge, pheasant; buying for sale prohibited.

Florida:

Deer, deer hides, quail or partridge, wild turkey.

Hawaii:

All game protected by the Territory.

Idaho:

All game protected by the State.

Illinois:

Deer, squirrel (gray, red, fox, black), quail, ruffed grouse (pheasant), pinnated grouse (prairie chicken), pheasant (except that cock pheasants may be sold from November 1 to January 1 by breeders under permit of State game commissioner), partridge (black Indian, caccabis, chukar), sand grouse; wild turkey, duck, goose, brant, killed within limits of State. Doves, woodcock, snipe, and plover may be sold from the third day of the open season to the fifth day of the close season, and game imported from other States from October 1 to February 1.

Indiana:

Quail. Woodcock, sale prohibited January 1-July 1.

Iowa:

All game, except during open season and five days thereafter.

Kansas:

Red squirrel, quail, partridge, grouse, pinnated grouse (prairie chicken), pheasant, dove, plover, duck, goose, brant (buying also prohibited).

Kentucky:

Quail, partridge, grouse, pheasant, wild turkey, killed within State.

Maine:

Deer, moose, or game birds for shipment beyond limits of State. Ruffed grouse, woodcock, all protected ducks, for any purpose. (Deer may be sold by local dealers under license.)

Maryland:

Anne Arundel—Quail, partridge, pheasant, woodcock, snipe, plover.

Baltimore City—Ruffed grouse, except October 1-December 25.

Frederick—Squirrel, partridge, pheasant, woodcock, taken in county.

Montgomery—Partridge, pheasant, wild turkey, for export.

Washington—Deer, squirrel, rabbit, partridge, pheasant, wild turkey, taken in county.

Wicomico, Worcester—Quail or partridge for export (both counties considered as one territ

Massachusetts:

Deer taken in the State, ruffed grouse, woodcock, quail, pinnated grouse. Dealers or perso the cold-storage business may sell quail during open season and thereafter until May 1. pinnated grouse, wood ducks, black ducks, and teal at any time.

Michigan:

All game protected by the State.

Minnesota:

All game protected by the State

Missouri:

All game protected by the State.

Montana:

All game protected by the State.

Nebraska:

Deer and antelope without horns, elk, squirrel, partridge, pheasant, ptarmigan, wild tur snipe (except Wilson snipe and yellow-legs), curlew. All other game, except during open son and five days thereafter.

Nevada:

Resale of all game.

New Hampshire:

Ruffed grouse or partridge, woodcock.

New Jersey:

Deer taken in the State, until April 5, 1906. All other game, except during open season fifteen days thereafter.

New Mexico:

Deer, elk, antelope, mountain sheep, native or crested and bobwhite quail, partridge, gro pheasant, ptarmigan, wild turkey, turtle dove, wild pigeon, killed within the Territory.

New York:

Grouse, woodcock taken in the State.[a] Quail taken in Delaware, Greene, Orange, Schoh Sullivan, and Ulster counties. Quail in other counties, except during open season and u January 1; deer, except September 1-November 21. (Possession or sale of deer November or quail, grouse, or woodcock, during December, presumptive evidence of illegal capture.)[b]

North Carolina:

Buncombe—Quail or partridge, pheasant, grouse, wild turkey, dove.

Catawba (except those killed on one's own land), Halifax, Iredell, Warren—Quail or partridg

Henderson—Wild fowl or game of any kind.

Randolph—Pheasant (to November 1, 1910).

Rowan—All protected game except during January and February.

North Dakota:

Deer, ruffed grouse, pinnated grouse, prairie chicken, sharp-tailed grouse, woodcock.

Ohio:

Squirrel, quail, ruffed grouse, Mongolian, English, or ring-neck pheasant, dove, woodcock, sn plover, rail, shorebird, duck, goose, swan, coot, mud hen, killed in the State for sale.

Oklahoma:

Deer, antelope, quail, grouse, prairie chicken, wild turkey, dove,

egon:

Deer,[c] elk, moose, mountain sheep, silver-gray squirrel, quail, bobwhite quail, partridge, gro ruffed grouse, capercailzie, moor hen, pheasant (silver, golden, copper, green Japanese, Reeves), ringneck or china (*Torquatus*) pheasant, wild turkey, woodcock, upland plover, duck, swan.

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[a] Also elk, caribou, and antelope; but when imported or killed in a private park by the own ey can be sold during the open season for deer.

[b] Pheasants bred or liberated in Suffolk County may be possessed in Greater New York for c sumption but not for sale.

[c] Except that five deerskins, properly tagged, may be sold in a season by the hunter who origin secured them. Tags not issued after first five days of close season.

Pennsylvania:

Deer, quail, partridge, grouse, pheasant, taken in the State; wild turkey, woodcock (wherever taken). Squirrel, rabbit or hare, bear, dove, reedbird, blackbird, upland plover, Wilson or jacksnipe, sandpiper, tatler, curlew, or any other shore bird, rail, coot or mud hen, duck, goose, brant, swan taken in the State, except during open season and fifteen days thereafter; ruffed grouse taken outside of the State except during open season and thirty days thereafter.

Rhode Island:

Quail, ruffed grouse, pheasant, woodcock.

South Carolina:

Deer, quail or partridge, wild turkey, taken in the State, until February 18, 1908.

South Dakota:

Deer, elk, buffalo, mountain sheep, except skins, heads, and antlers of animals lawfully killed.

Tennessee:

All game, except during open season and five days thereafter. Wild turkeys can not be sold in Dyer County at any time.

Texas:

All game animals, hides and horns, wild birds, and wild fowl found within the State.

Utah:

Deer, elk, antelope, mountain sheep, quail, partridge, grouse, prairie chicken, sage hen, pheasant, Mongolian, Chinese, and English pheasant, dove.

Vermont:

Quail, ruffed grouse, pheasant or English partridge, English snipe, plover, woodcock, duck, goose, except for consumption as food within the State.

Virginia:

English or Mongolian pheasant (except for propagation) until January 1, 1909.

Carroll, Grayson, Greenesville, Patrick, Sussex—Quail or partridge taken in county.

Clarke—Quail, rabbit, squirrel, pheasant, wild turkey (outside of county).

Frederick, Shenandoah—Quail, ruffed grouse, wild turkey, woodcock (prohibition applies only to nonresidents of Virginia).

Page—Quail (for export).

Washington:

Deer, elk, moose, caribou, mountain sheep, mountain goat, quail, partridge, grouse, prairie chicken, sage hen, ptarmigan, pheasant, Chinese or Mongolian pheasant, sand-hill crane, plover, rail, swan, and all other game birds except duck, goose, brant, which may be sold during November, but only 25 in a day.

Wisconsin:

Venison, quail, partridge, grouse, prairie chicken, pheasant, Mongolian, Chinese, or English pheasant, snipe, plover, woodcock, duck, goose, brant, or other aquatic bird.

Wyoming:[a]

Deer, elk, moose, antelope, mountain sheep, or skins, heads, antlers, or teeth thereof.

British Columbia:

Elk, heads of moose, caribou, and sheep, quail, grouse, ptarmigan, prairie chicken, English partridge, pheasant, swan; also female and young of deer,[b] elk, moose, caribou, or mountain sheep.

Deer (male), except from September 1; moose (male), caribou (male), mountain sheep (male), mountain goats, and hares, except from October 1; and snipe, plover, and ducks, except during open season—all to five days after close of season.

Manitoba:

Deer, elk, moose, caribou, antelope (except heads and hides), quail, grouse, pheasant, partridge, prairie chicken, woodcock, plover, snipe, sandpiper.

New Brunswick:

Geese and brant, except during open season and until March 1. All other game, except during open season and, under license from game warden, ten days thereafter.

Newfoundland:

Caribou, except August 1–January 1; ptarmigan or willow grouse, except during open season and ten days thereafter.

Northwest Territories:

Mountain sheep, mountain goat, or prairie chicken, grouse, pheasant, ptarmigan, or other member of the Gallinæ, unless captured by owner.

Nova Scotia:

Pheasant, blackcock, capercailzie, ptarmigan, sharp-tailed grouse, Canada grouse (spruce partridge), chukar partridge. Deer, moose, and caribou, except September 15–January 5. Ruffed grouse (partridge), woodcock, snipe, teal and other ducks, except during all but first three days of open season.

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[a] Sale of 1 hide, 1 scalp, and 1 head of any big game, except moose, and 1 pair of elk tusks permitted on affidavit that they were taken from animals lawfully killed.

[b] Male deer can not be sold on Vancouver Island.

Ontario:

Quail, partridge, woodcock, snipe, until September 15, 1910. All other game, except during open season[a] and during such period in close season (not exceeding twenty days in the case of domestic game) as may be fixed by the game commission.

Quebec:

Birch or swamp partridge, until October, 1905. All other game, except during open season and fifteen days thereafter.

Yukon:

Deer, elk, moose, caribou, bison, musk oxen, sheep, and goats, except during open season and sixty days thereafter.

LICENSES FOR HUNTING AND SHIPPING GAME.

In Arkansas nonresidents are not permitted to hunt, except on their own premises, and in 36 States and Territories,[b] and throughout Canada, licenses must be secured before nonresidents can hunt any or certain kinds of game (see fig. 2, p. 4). In 16 States and four Canadian Provinces a like restriction is imposed on residents, but the fees are usually very much smaller, and often are merely nominal (see fig. 1, p. 4). The fees for nonresident licenses which permit hunting of both big and small game range from $10 in a number of States to $50 in Wyoming, British Columbia, and Newfoundland; those for resident licenses from 75 cents in Illinois and North Dakota to $5 in Washington, and $7 ($5 for moose and caribou and $2 for deer) in Ontario.

A new kind of hunting license that has recently come into use is what may be called the "alien" license, which places persons who are not citizens of the country in a special class or treats them as nonresidents, even though they are residents of the State. Thus Pennsylvania, Louisiana, Utah, and Wyoming provide that all hunters who are unnaturalized residents of the State must pay the fee exacted of nonresidents; Massachusetts has a special $15 license for resident aliens, Washington a $50 license for nonresident aliens, and Manitoba has a $100 license for all who are not British subjects.

Licenses are generally issued only for a season, and thus expire at fixed dates. Some are necessarily very brief in duration. Michigan issues a $25 nonresident deer license good only from November 10 to December 1; Vermont a $15 nonresident deer license good only for the last six week days of October. In a few instances brief licenses are issued independently of the length of the season. Of this character are a $5 nonresident bird license, good for one week, issued by British Columbia; a five-day guest license, with a fee of $1, issued by the Northwest Territories; daily licenses issued for hunting birds in Colorado and any game in Lafayette County, Fla.

Six States issue licenses good only in the county named therein—Florida, Georgia (market hunting), Iowa, Maryland, South Carolina, and South Dakota—with fees ranging from $1 for residents of Washington to $50 for residents hunting ducks for market in South Carolina.

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[a] Seasons depend on regulations of game commission.

[b] Not including Georgia, in which a license must be secured to hunt for market.

Twenty-two States and six Canadian Provinces allow nonresident licensees to carry or ship out of the State or Province a limited amount of game, while this privilege is denied by 14 States and Territories and two Canadian Provinces. Maine, Michigan, and Montana issue export permits additional to the hunting license.

Nonresident landowners or taxpayers are not required to pay the usual fee in Kansas, Maryland (most counties),[a] New Hampshire, New Jersey, North Dakota, Tennessee, West Virginia, and Nova Scotia. But to secure this exemption in New Hampshire the nonresident hunter must own land to the value of $500 or more, in Tennessee and Nova Scotia he must pay a tax of at least $100 or $20 per annum, respectively, and in North Dakota must own or cultivate a quarter section of land. Similar exemptions are made in the case of landowners and, in some instances, their tenants, hunting on their own land in Colorado (farming or grazing lands only), Illinois, Missouri, Montana, North Dakota, and Oregon, and no license is required of those hunting within their own township in Indiana or county in Minnesota or Nebraska. In Virginia no nonresident license is required of bona fide guests of residents, and in the Northwest Territories a special five-day guest license is issued.

In Maine,[b] South Dakota, Wyoming, and New Brunswick (on wild lands) nonresidents are not permitted to hunt big game unless accompanied by qualified guides, and in Colorado, Maine, Montana, Wyoming, New Brunswick, Newfoundland, and Ontario guides are licensed. Maine and New Brunswick also license camp help. Nearly every State requires licensees to have their licenses in personal possession while hunting, and to exhibit them on demand of any warden (in New Hampshire of any person).[c]

Georgia, Louisiana (nonresidents), Oregon (nonresidents), South Carolina (residents), and Tennessee issue market-hunting licenses.

Details in regard to hunting licenses are given in the following table. In a few States an additional clerk's fee, 25 cents to $1, is required, but this item is not included in the fees given below.

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[a] All the counties of Maryland allow nonresidents to hunt without license on invitation of landowners except Allegany, Caroline, Dorchester (unless relatives), Garrett, Kent, Talbot, Wicomico (unless accompanied by a resident) and Worcester counties.

[b] On wild lands of the State, except from December 1 to 15.

[c] In North Carolina hunters are required to obtain written permission for hunting on lands other than their own in the following counties: Alexander, Alleghany, Anson, Beaufort, Buncombe, Carteret, Caswell, Clay, Craven, Currituck, Davidson, Edgecombe, Franklin, Halifax, Henderson, Hertford, Iredell, Jones, Lincoln, McDowell, Macon, Madison, Martin, Mecklenburg, Mitchell, Moore (?), Orange, Pitt, Randolph, Richmond, Rowan, Rutherford, Surry, Transylvania, Wayne, Wilkes, and Yadkin.

Details of hunting licenses, with bag limits, and export regulations.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
Alabama						12 or 15 counties prohibit all export.
Alaska					2 moose, 4 each of caribou, sheep, goats, large brown bears, 8 deer a year; 10 grouse or ptarmigan, 25 shore birds or waterfowl a day.	In discretion of Secretary of Agriculture, who issues permit in each case.
Arizona	Nonresident	$10.00	Fish and game commissioner or county recorder.	Deer only	3 deer a season, 25 quail a day	No export.
Arkansas				Nonresidents not permitted to hunt.[a]		Do.
California					2 deer a season; 25 each of quail, partridges, snipe, plover, curlew, shore birds, rail, ibises, and doves, and 50 ducks a day.	Do.
Colorado	Nonresident	25.00	Commissioner of game	Expires Dec. 31	1 deer a season; 25 ducks a day, 100 in possession at once; 25 other birds a day, 50 in possession at once.	Permit required.
	Nonresident	2.00	do	County license for birds, $2 first day; each subsequent day $1. Expires Dec. 31.		
	Resident	1.00	Commissioner or county clerk.	Expires Dec. 31. Owners of farms or grazing lands hunting on their premises exempt.		
	Guide	5.00	Commissioner of game	Expires Dec. 31. Must have in addition a State license.		
Connecticut					5 ruffed grouse a day, 36 a year; 50 each of plover, rail, snipe, shore birds a day.	No quail, ruffed grouse, or woodcock.
Delaware	Nonresident	5.00	Delaware Game Protective Association.	$2 for each subsequent year		No rabbit, quail, partridge, robin, woodcock, Wilson snipe.
Florida	Noncitizen	10.00	Clerk of circuit court	County license. Expires Mar. 1.[b]	5 deer, 5 turkeys a year; 20 quail, 2 turkeys by individual or 40 quail, 4 turkeys by party a day.	No deer, quail, or wild turkeys.
Georgia	Market hunting	25.00	Ordinary of county	County license; permits killing for sale. Expires Dec. 31.	40 doves a day	No quail.
Idaho	Nonresident	25.00	State warden, deputy, or justice of the peace.	Expires Jan. 31	2 deer, 1 ibex, 1 goat, 1 sheep, 1 elk a season; 18 each of quail, sage hens, partridges, pheasants, grouse, prairie chickens or fool hens, 24 ducks, 3 geese, 3 swans a day.	2 deer, 1 ibex, 1 mountain goat, 1 mountain sheep, 1 elk. No birds.
	Nonresident	5.00	do	Birds only. Expires Jan. 31		
	Resident	1.00	do	Expires Jan. 31		

				tenants of farm lands hunting on their lands exempt.	day.	
Indiana	Nonresident	15.00	Clerk of circuit court	Good for 1 year	24 quail, 24 ducks or other waterfowl a day.	24 birds of all kinds.
	Resident	1.00	Commissioner of fisheries and game.	Good for 1 year. Person hunting in township of residence exempt.		
Iowa	Nonresident	10.00	County auditor	County license. Expires Jan. 1.	25 each of quail, prairie chickens, ruffed grouse or pheasants, woodcock, wild turkeys, ducks, geese, brant a day.	25 of all kinds of game.
Kansas	Nonresident	15.00	Secretary of state	Owner of land and members of hunting club hunting on their premises, exempt. Expires June 30.	20 each of quail, plover, duck; 15 each of grouse, prairie chickens; 10 each of geese, brant a day.	No export.
	Resident	1.00	County clerk	do		
Kentucky	Nonresident		do	Expires 1 year from date of issue. Same fee as resident of Kentucky is subject to in State of nonresident.		Do.
Louisiana	Nonresident	10.00	Sheriff	Required of nonresidents and unnaturalized residents.	6 deer a season; 75 snipe and ducks; 25 other birds a day.	1 deer, 12 birds.
	Market hunting	25.00	do			
Maine	Nonresident	15.00	Commissioners of inland fisheries and game.	All game during Oct., Nov., and Dec.	1 moose, 2 deer a season, except in Cumberland, Knox, Kennebec, Lincoln, Sagadahoc, Waldo, and York counties, limit 1; 15 each of ruffed grouse, woodcock, plover, snipe, ducks, and 70 sandpipers a day.	1 moose, 2 deer, 15 birds of each species, and 10 each of partridges, ducks, and woodcock additional.
	Nonresident	5.00	do	Game that may be shot before Oct. 1. Licensee may procure moose and deer license by payment of $10 additional.		
	Camp keeper	5.00	do			
	Guide (nonresident).	20.00	do	Expires Dec. 31. Guide to be registered, and to guide not more than 5 persons at a time.		
	Guide (resident)	1.00	do	do		
	Shipment		do	Moose, $5; deer, $2; pair of game birds, 50 cents. Permits shipping home or to hospital in State.		
Maryland	Nonresident	4.50 25.00	Clerk of circuit court	Separate county laws [c]		Local laws.

[a] But see State v. Mallory, 83 S. W. 955, deciding that nonresidents may hunt on their own land.

[b] Not applicable to counties having special game laws. Nonresidents of Lafayette County required to secure license of game warden and pay therefor $1 per day.

[c] County and local licenses are issued at the following rates: Garrett, $25; Charles (upland game), Prince George, St. Mary, $20; Frederick, Kent, Montgomery, $15; Allegany, Calvert, Carroll, Harford, Patuxent River, Somerset, Washington, Wicomico, Worcester (wild fowl), $10; Talbot, $9.50; Howard, $7.50; Baltimore, Cecil (upland game and shore birds), Dorchester, $5; Caroline, Queen Anne, $4.50. In Kent the fee is $5 if nonresident is invited by a landowner or resident, and in Washington no license is required of residents of Maryland or the District of Columbia. These licenses are usually not required of guests of resident landowners (see p. 41), or nonresident taxpayers. In Somerset County a $1 resident license is required.

Details of hunting licenses, with bag limits, and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
Massachusetts	Alien	$15.00	City and town clerk	Required of unnaturalized foreign-born residents. Nonresident aliens not permitted to hunt.		No native quail, ruffed grouse, or woodcock.
Michigan	Nonresident	25.00	County clerk	Deer. Good for season	2 deer a year; 12 each of grouse, spruce hen a day, 50 in possession at a time; 25 ducks, water fowl, snipe, plover, woodcock a day, 75 in possession at a time.	1 deer.
	Resident	1.50	do	do		
	Export	10.00	State game and fish warden.			Allows nonresident landowner and member of a club that maintains a game preserve to export 50 ducks or migratory birds killed by him on said premises.
Minnesota	Nonresident	25.00	Board of game and fish commissioners.	Game animals. Expires Dec. 31.	1 deer (nonresident), 2 deer (resident), 1 moose a season, 15 birds a day.	1 deer, 25 birds.
	Nonresident	10.00	do	Game birds. Expires Dec. 31.		
	Resident	1.00	County auditor	Not required for county of residence. Expires Dec. 31.		
Mississippi.						
Missouri	Nonresident	15.00	State game and fish warden.	Expires Dec. 31	1 deer, 2 turkeys, 25 of any other species a day; or 2 deer, 4 turkeys, 50 of any other species in possession at a time.	
	Resident	1.00	County clerk	Expires Dec. 31. Owners and tenants hunting on their farms exempt.		
Montana	Nonresident	25.00	State game and fish warden or deputy.	Expires Dec. 31	3 deer, 1 elk, 1 goat, 1 sheep a season; 10 each of grouse, prairie chickens, fool hens, pheasants, sage hens, partridges, turtle doves a day.	Number permitted to be killed under hunting license.
	Nonresident	10.00	do	Birds only. Expires Dec. 31		
	Resident[a]	1.00	State game and fish warden or deputy or justice of the peace.	Expires Dec. 31. Landowner hunting on his own premises exempt.		
	Guide	10.00	State game and fish warden.	Good for 1 year		
	Shipping	.50	do	Permits limited export in open season.		
Nebraska	Nonresident	10.00	Game and fish commissioner or county clerk.	Expires Dec. 31	1 deer, 1 antelope, or 2 of one kind a season; 10 prairie chickens a day in Sept.; 25 quail, sage chickens, prairie chickens or grouse, wild pigeons, doves,	No deer or antelope; 50 birds.

Nevada[a]					3 deer, 3 antelope a season; 20 quail, 20 ducks, and 20 sage hens, 6 grouse, 5 plover, 15 snipe a day.	No export.
New Hampshire	Nonresident	10.00	Fish and game commissioners.	Expires Dec. 31. Required for hunting, Oct. 1-Dec. 15. Owners of real estate to value of $500 exempt.	2 deer a season	12 birds.
New Jersey	Nonresident	10.00	County clerk	All game except wild waterfowl, snipe, and mud hens. Expires 1 year from date of issue. Nonresident owners of freehold estate and their sons exempt from fee.	30 marsh hens a day	No upland game except wild turkeys.
New Mexico					1 deer a season	No export for sale.
New York	Nonresident		Forest, fish, and game commissioner.	Same fee and conditions as resident of New York is subject to in State of nonresident, or if none, such as commissioner shall prescribe.	2 deer, 36 grouse, 36 woodcock a season; quail, grouse, woodcock in Orange County, 12 of each a day, 36 of each a calendar year.	No export.
North Carolina	Nonresident	10.00	Clerk of superior court	Good for season only		50 partridges or quail.
North Dakota	Nonresident	25.00	County auditor	Expires Dec. 31. Nonresident owning or cultivating a quarter section of land may take out resident license in county where land lies.	5 deer a season; 25 birds a day.	No export.
	Resident	.75	do	Expires Dec. 31. Citizen hunting on his own land exempt.		
Ohio	Nonresident	15.00	County clerk	Expires December 15	10 squirrels; 18 each of quail, doves, woodcock, snipe, plover, rail, shore birds, geese; 25 ducks; 6 each of pheasants, prairie chickens, or grouse a day.	50 animals and birds.
klahoma						No export.
gon	Nonresident	10.00	County clerk	Good for one year. Landowners hunting on their own premises exempt.	5 deer a season; 10 each of quail (east of Cascades, 6 a day, 12 a week), grouse, prairie chickens, ring-neck pheasants a day; 50 ducks a week.	
	Market hunting.	10.00	Game and forestry warden.	Nonresident. Expires Dec. 31		No export allowed, except by Washington hunters, who may take one day's bag.
	Resident	1.00	County clerk	Good for one year. Landowners hunting on their own primeses exempt.		
ylvania	Nonresident	10.00	County treasurer	Required of nonresidents and unnaturalized residents. Good for year of issue.	1 deer a season, 6 squirrels a day; 5 each of ruffed grouse, introduced pheasants, 10 woodcock a day, 20 a week, 50 a season; 10 quail a day, 40 a week, 75 a season; 1 wild turkey a day, 4 a season; 10 ducks a day, 100 a season; 2 geese, brant a day, 10 each a season.	No export.

[a] United States soldiers stationed in the State classed with residents.

Details of hunting licenses, with bag limits, and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
Rhode Island						No quail, ruffed grouse, or woodcock.
South Carolina	Nonresident	$10.00	County treasurer	County license for hunting on public lands and navigable waters. Expires Dec. 31.		No deer, quail, or wild turkey for sale.
	Market hunting.	50.00	do	County license for residents hunting wild fowl on public lands and navigable waters. Expires Dec. 31.		
South Dakota	Nonresident	25.00	do	County license for big game. Issued Nov. 1. Expires Dec. 31. Nonresident licensee must be in charge of guide.	2 deer, 1 elk, 1 buffalo, 1 sheep a year; 15 birds a day.	2 deer, 1 elk, 1 buffalo, 1 sheep, 15 birds.
	Resident	2.50	do			
	Nonresident	10.00	do	State license (birds) for season.		
Tennessee	Nonresident	[a] 10.00	State game warden	Expires Dec. 31. Property owners who pay $100 in taxes exempt.	50 ducks: 80 of all other birds in aggregate a day [b]	
	Market hunting.	25.00	do	Annual license; licensee required to give $200 bond for faithful compliance with law.		
Texas					6 deer a season; 25 birds a day	No export.
Utah	Nonresident	25.00	State fish and game commissioner.	Required also of aliens; good for 1 year.	Quail in Davis, Salt Lake, and Weber counties, 12 a day; 8 each of partridges, pheasants, prairie chickens, sage hens, grouse, mourning doves, and 25 in all of snipe, shorebirds, ducks, geese, brant, swans a day.	Do.
Vermont	Nonresident	15.00	do	Deer only	1 deer and 15 ruffed grouse a season; 5 each of gray squirrels, quail, ruffed grouse, pheasants, woodcock, plover, English snipe, geese, and 20 ducks a day.	1 deer; no birds.
Virginia [c]	Nonresident	10.00	County clerk	Good in open season in the 6 months following issue.		1 deer, 50 quail, 10 pheasants or grouse, 8 wild turkeys, 80 waterfowl, 25 of each or 100 in all, plover, snipe, sandpipers, willets, tatlers, and curlews.

	Resident	1.00	State or county auditor	County license. Good for 1 year.	rail, cranes, snipe, ducks, or other waterfowl a day.	
West Virginia	Nonresident	15.00	State game warden	Good for 1 year. Landowners hunting on their own property exempt.	2 deer a season; 12 quail a day.	No deer, quail, ruffed grouse, pheasants, wild turkeys.
Wisconsin	Nonresident	25.00	Secretary of state		2 deer a year; 15 grouse, prairie chickens, woodcock, 25 partridges or pheasants, 30 geese, ducks, plover, snipe a day.	2 deer, 50 birds.
	Nonresident	10.00	do	All game except deer		
	Resident [d]	1.00	County clerk			
Wyoming	Nonresident	50.00	Justice of the peace	Expires Dec. 31. Required also of aliens. Licensee must employ guide.	2 deer, 2 elk, 2 antelope, 1 sheep a season; 12 birds a day.	2 deer, 2 elk, 2 antelope, 1 sheep
	Nonresident	5.00	do	Birds only. Expires Dec. 31.		
	Resident [e]	2.00	do	Big game only. Expires Dec. 31.		
	Guide [f]	10.00	do	Good for 1 year.		
British Columbia.[g]	Nonresident	50.00	Game warden or any government agent.	Members of army or navy or Canadian militia in actual service exempt.	5 deer, 2 elk, 2 moose, 5 caribou, 5 goats, 3 sheep, 250 ducks and snipe a season.	Heads, hides, and horns of animals legally killed by nonresident licensees.
	Nonresident	5.00	do	Birds only. Good for one week only.		
Manitoba	Alien	100.00	Minister of agriculture and immigration.	Nonresident	1 deer, 1 elk, 1 moose, 1 caribou, 1 antelope a season; 20 each of grouse, partridges, prairie chickens a day, 100 a season.	No export.
	Nonresident	25.00	do	British subject		
	Resident	2.00	do	Animals, only		
New Brunswick.[g]	Nonresident	50.00	Surveyor-general; chief game commissioner; any game warden.	Moose, caribou, and deer[h]	2 deer, 1 moose, 1 caribou a season.	No partridge; other game under permit.
	Nonresident	50.00	do	In Westmoreland County		
	Resident	2.00	do	Moose, caribou, and deer		
	Resident	.25	do	In Westmoreland County		

[a] Except in Carroll, Cannon, Clay, Coffee, Dekalb, Dyer, Fayette, Fentress, Franklin, Hamilton, Hardeman, Henry, Houston, Lake, Lawrence, Lewis, Lincoln, Macon, Marshall, Monroe, Montgomery, Overton, Pickett, Putnam, Robertson, Rutherford, Smith, Stewart, Warren, Wayne, White, and Wilson counties, where nonresident is required to pay same fee resident of Tennessee must pay in State of nonresident.

[b] Not applicable to counties enumerated in footnote [a].

[c] Guests not required to procure license to hunt on land of host, provided the host receives no compensation, directly or indirectly, from such guest.

[d] Bona fide settlers who have not resided in the State 1 year may take out a resident license.

[e] Applicant must be an elector of the State, child or ward, over 14 years, of an elector, or a soldier or sailor of the United States and an elector thereof, stationed 1 year at a post in the State. Soldier and sailor must employ guide.

[f] Guide must be citizen and qualified elector of State; must act as assistant game warden; and is equally responsible with employer for violation of law.

[g] See general Canadian export restrictions, p. 34.

[h] Nonresidents hunting big game on wild lands must be in charge of registered guide.

Details of hunting licenses, with bag limits, and export regulations—Continued.

State.	Kind of license.	Fee.	By whom issued.	Details of license.	Bag limit.	Export limit.
New Brunswick—Cont'd.	Guide	$2.00	Surveyor-general; chief game commissioner; any game warden.	Resident accompanying any-one hunting big game.		
	Camp help	1.00	do	Resident		
	Camp help	50.00	do	Nonresident		
Newfoundland[a]	Nonresident	50.00	Stipendiary magistrate; justice of the peace; minister of marine.	Good for season. Licensee can not employ unlicensed guide.	3 caribou	3 caribou under license and permit.
	Guide	25.00	do	Nonresident. Resident guide licenses free.		
Northwest Territories.[b]	Nonresident	25.00	Game guardian	Expires Dec. 31	3 deer, 3 elk, 3 moose, 3 caribou a season;[c] 20 grouse, partridges, pheasants, prairie chickens, ptarmigan, a day, or 200 a season.	Under general license, trophies of big game legally killed.
	Nonresident	15.00	do	Birds only. Expires Dec. 31		
	Guest	1.00	do	Guests of residents hunting with them. Good for 5 days.		
Nova Scotia[b][d]	Nonresident	30.00	Provincial secretary, clerk of municipality, or agent of game society.	Expires Aug. 1	2 moose a season	Any moose and caribou lawfully killed by licensee.
Ontario[b]	Nonresident	25.00	Chief warden		2 deer, 1 moose, 1 caribou a season.	2 deer, 1 moose, 1 caribou, 100 ducks.
	Resident	5.00	do	Moose and caribou		
	Resident	2.00	do	Deer		
	Guide	2.00?	do	Optional with chief warden and game commissioners.		
Quebec[b]	Nonresident	25.00	Commissioner of lands, forests, and fisheries.		Zone 1: 2 deer, 2 caribou, 1 moose a season. Zone 2: 2 deer, 1 moose, 4 caribou a season.	
	Nonresident	20.00	do	Game animals		
	Nonresident	10.00	do	Game birds; good for season[e]		
	Resident	5.00	do	Three deer and 3 caribou additional to bag limit.		

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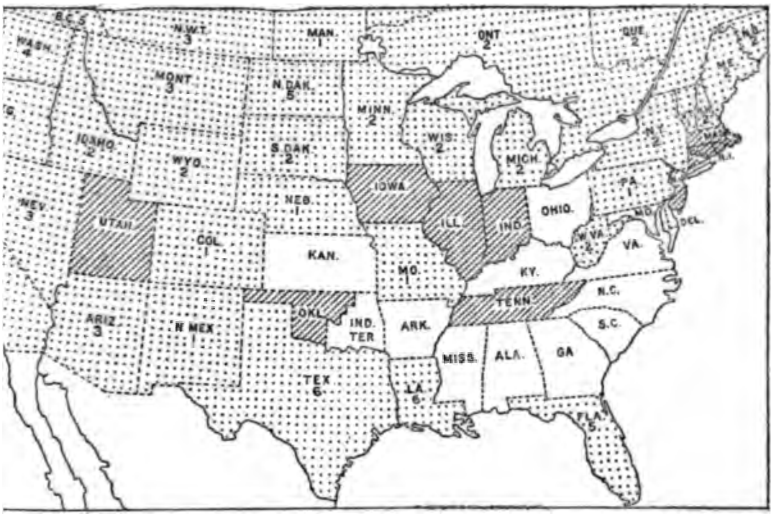
[a] Any officer of a British war ship stationed on the coast of Newfoundland for fisheries protection may obtain a free hunting license good for six weeks of open season, and may employ unlicensed guide.

[b] See general Canadian export restrictions, p. 34.

[c] Two each of these animals in southeastern Assiniboia.

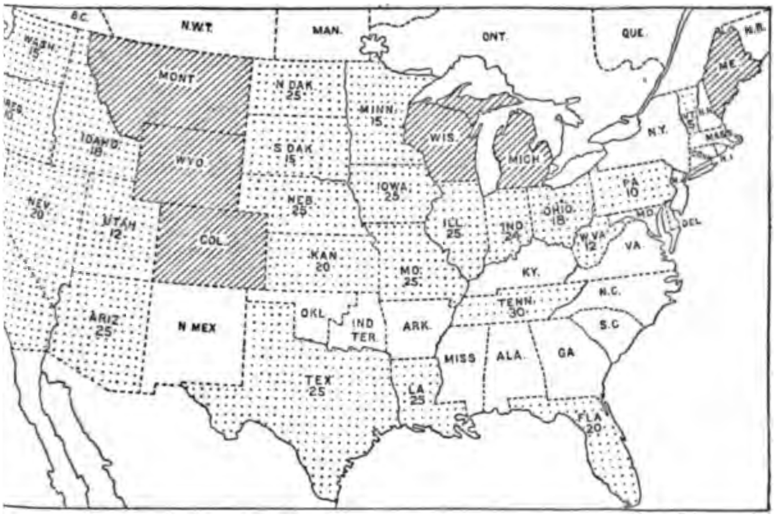
[d] Former residents, in Government employ, who are members of the Game Society, require no license. Nonresident landowners, paying $20 or more annual taxes, require licenses but pay no fee. Officers of the army or navy stationed in Nova Scotia pay $5 fee, unless members of the Game Society, in which case they require no license.

[e] Separate license required for shooting game birds in Gulf of St. Lawrence.



:tates and Provinces which limit the number of deer that may be killed by one person in a season (in Missouri in a day).

areas indicate States which permit no killing; blank areas those which set no limit.



6.—States which limit the number of quail that may be killed by one person in a day.

areas indicate States which permit no killing; blank areas, those which set no limit.

MAPS SHOWING NUMBER OF DEER AND QUAIL THAT MAY BE KILLED.

APPENDIX.—TABLES SHOWING CLOSE SEASONS FOR GAME 1 COUNTY LAWS.

In several States local laws prevail to such an extent as to special tables. The county laws of Virginia and Tennesse repealed in 1903, but local laws are still the rule in Alabama, land, and North Carolina. In California under the county gove act of April 1, 1897, boards of supervisors were authorized to the open seasons for game, and this privilege was exercised an extent as materially to modify the seasons fixed by the Sta Recently, however, the district court of appeal of the second late district, in passing on the constitutionality of the dove orc of Los Angeles County, declared this authority abrogated amendment to the Constitution (Art. IV, sec. 25½) adopted i (see Ex parte Prindle, decided July 29, 1905); consequently thes seasons are not here included.

In the following table the season for each kind of game unc State law (if any) is first given, after which the local exceptic stated by counties.

ALABAMA.[a]

Close seasons for game under county laws.

Kinds of game.	Close seasons.
Deer:	
Baldwin, Escambia, Lamar, Shelby.	Feb. 1-Nov. 1.
Bibb	Feb. 14-Oct. 20.
Calhoun, Clarke, Crenshaw, Dekalb, Lee, Tallapoosa, Tuscaloosa, Washington.	Mar. 1-Oct. 1.
Cherokee	Feb. 15-Sept. 15.
Choctaw	Apr. 20-Oct. 15.
Conecuh, Wilcox	Mar. 1-Nov. 1.
Cullman, Limestone, Madison.	Feb. 1-Sept. 1.
Dallas, Hale (except beat 17, Jan. 10-Nov. 1), Macon.	Feb. 1-Oct. 1.
Etowah	Until Oct. 9, 1908.
Greene	Jan. 10-Nov. 1.
Houston	Mar. 1-Nov. 15.
Marengo, Pike	Apr. 1-Sept. 15.
Montgomery	Mar. 15-Sept. 15.
Perry	Feb. 14-Oct. 15.
Sumter	Feb. 15-Oct. 15.
Walker	Apr. 15-Oct. 15.
Winston (beat 5 only)	Apr. 15-Sept. 16.
Squirrel:	
Conecuh	Mar. 1-Nov. 1.
Henry	May 1-Oct. 1.
Squirrel—Continued.	
Houston, Madison, Perry (all State law).	Feb. 2-J
Lee	Apr. 1-O
Macon	Feb. 1-J
Opossum:	
Lee	Apr. 1-O
Macon	Jan. 1-S
Pickens	Feb. 12-
Quail (or partridge):	
Baldwin, Escambia	Feb. 1-N
Barbour, Cullman, Limestone, Madison, Tallapoosa.	Apr. 1-O
Bibb	Mar. 15-
Bullock	Mar. 16-
Calhoun, Crenshaw, Houston, Lee, Tuscaloosa.	Mar. 1-N
Chambers	Mar. 10-
Choctaw	Apr. 20-
Clarke, Dekalb, Washington.	Mar. 15-
Conecuh, Greene, Marengo, Perry.	Mar. 1-N
Dallas, Hale, Macon, Pike, Russell, Wilcox.	Mar. 15-
Etowah, Lamar, Shelby	Mar. 15-
Lowndes, Montgomery	Mar. 15-

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[a] The term "State law" is used to indicate the seasons fixed by the general law of 1899 b distinction to the special county laws.

ALABAMA—Continued.

Close seasons for game under county laws—Continued.

inds of game.	Close seasons.
partridge)—Cont'd.	
an	Mar. 1-Oct. 15.
er	Jan. 15-Nov. 15.
dega	Feb. 1-Nov. 20.
er	Apr. 15-Oct. 15.
prairie chicken, nt (including Eng- ongolian, Chinese), ck (State law):	
ton, Macon, Madi- , Perry.	Mar. 1-Nov. 15.
:	
ah	Mar. 15-Oct. 15.
key:	
win, Escambia	Feb. 1-Nov. 1.
our	May 1-Nov. 1.
	Apr. 1-Oct. 20.
ck, Calhoun, Cull- n, Limestone, Madi- , Russell.	May 1-Oct. 1.
kee	Feb. 15-Sept. 15.
taw	Apr. 20-Oct. 15.
e, Dekalb, Marengo, e, Tallapoosa, Wash- ton.	Apr. 1-Oct. 1.
uh (except female, r. 1-Nov. 1), Wilcox.	Apr. 1-Nov. 1.
haw, Lee, Tusca- sa.	Apr. 15-Oct. 1.
s, Hale, Perry	May 1-Oct. 15.
ah	Feb. 1-Dec. 1.
ne	Apr. 15-Nov. 1.
ton	Mar. 1-Nov. 15.
r, Shelby	Apr. 25-Oct. 15.
Kind of game.	**Close seasons.**
Wild turkey—Continued.	
Macon	Mar. 1-Nov. 1.
Montgomery	Mar. 15-Nov. 15.
Sumter	May 1-Sept. 15.[a]
Walker	May 15-Oct. 15.
Winston (beat 5 only)	Apr. 15-Sept. 16.
Dove:	
Baldwin	Feb. 1-Aug. 15.
Barbour, Calhoun, Crenshaw, Lee, Lowndes, Russell, Tallapoosa, Tuscaloosa.	Apr. 1-July 15.
Bibb	Apr. 1-July 1.
Bullock, Clarke, Lamar, Shelby.	Mar. 1-July 15.
Conecuh	Mar. 1-Nov. 1.
Dallas, Hale, Walker	Mar. 15-July 15.
Dekalb, Washington	Mar. 1-Oct. 1.
Escambia	Feb. 1-Nov. 1.
Etowah	Mar. 15-Oct. 15.
Greene	Feb. 1-Aug. 1.
Houston	Mar. 1-Nov. 15.
Macon, Madison (State law), Marengo, Sumter.	Mar. 1-Aug. 1.
Montgomery	Mar. 1-Sept. 1.
Perry	Mar. 15-July 1.
Pike	Mar. 15-Nov. 1.
Duck:	
Baldwin, Escambia	Feb. 1-Nov. 1.[b]
Montgomery	Mar. 1-Nov. 15.
Perry	Apr. 1-Oct. 1.
Snipe:	
Houston	Mar. 1-Nov. 15.

---

[a] Gobblers; hens, Mar. 15-Oct. 1.

[b] Except summer duck (unprotected).

MARYLAND.[a]

Close seasons for game under county laws. [b]

inds of game.	Close seasons.
any	Jan. 1-Oct. 15.
tt	Until Sept. 30, 1906.
ington	Jan. 1-Nov. 1.
Dec. 1-Sept. 1 (ex- follows):	
any	Jan. 1-Sept. 1.
Arundel	Dec. 24-Sept. 1.
more	Dec. 25-Nov. 1.
ine	Jan. 16-Sept. 1.
ester	Jan. 21-Nov. 20.
erick (gray or fox)	Nov. 15-Sept. 1.
	All the year.
gomery (gray)	Dec. 15-Aug. 1.
rset	Dec. 2-Sept. 1.
ington	Dec. 25-Sept. 15.
mico	Feb. 15-Sept. 1.
ett (State law), nce George.	Unprotected.
more, Baltimore City le), Calvert, Kent, shington (State law).	Dec. 25-Nov. 1.
any	Jan. 1-Oct. 15.
Arundel, Carroll, ward.	Dec. 25-Nov. 10.
Kind of game.	**Close seasons.**
Rabbit—Continued.	
Caroline	Jan. 16-Nov. 16.
Cecil	Jan. 10-Nov. 1.
Charles	Jan. 15-Oct. 15.
Dorchester	Jan. 21-Nov. 20.
Frederick	Dec. 25-Nov. 1.
Garrett (State law)	Feb. 1-Nov. 1.
Harford	Dec. 1-Nov. 1.
Montgomery[c]	Dec. 20-Nov. 1.
Prince George	Dec. 26-Nov. 9.
Queen Anne	Dec. 25-Nov. 15.
St. Mary	Jan. 16-Nov. 1.
Somerset	Jan. 2-Nov. 15.
Talbot	Jan. 1-Nov. 1.
Wicomico, Worcester	Jan. 15-Nov. 15.
Quail (or partridge):	
Baltimore, Baltimore City (sale), Charles, Frederick, Kent, Washington (State law).	Dec. 25-Nov. 1.
Allegany	Jan. 1-Oct. 15.
Anne Arundel	Dec. 25-Nov. 10.
Calvert	Jan. 11-Nov. 1.
Caroline, Somerset	Jan. 16-Nov. 16.
Carroll, Howard	Dec. 25-Nov. 10.
Cecil	Jan. 10-Nov. 1.

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erm "State law" is used to indicate the seasons fixed by the public general law of 1898 in stinction to the special county laws.

nlawful to hunt on election day in Baltimore, Frederick or Harford counties, and in Fred- inty it is unlawful to hunt with gun or rifle Oct. 10-Nov. 1.

g by other means than shooting prohibited Nov. 1-Jan. 15.

MARYLAND—Continued.

Close seasons for game under county laws—Continued.

Kinds of game.	Close seasons.
Quail (or partridge)—Cont'd.	
Dorchester	Jan. 21-Nov. 20.
Garrett, Harford	Dec. 1-Nov. 1.
Montgomery	Dec. 20-Nov. 1.
Prince George	Dec. 26-Nov. 9.
Queen Anne	Dec. 25-Nov. 15.
St. Mary	Dec. 25-Nov. 1.
Talbot	Jan. 1-Nov. 1.
Wicomico, Worcester	Jan. 15-Nov. 15.
Ruffed grouse (or pheasant):	
Baltimore, Calvert, Caroline, Charles, Frederick, Kent, Talbot (State law).	Dec. 25-Nov. 1.
Allegany	Jan. 1-Oct. 15.
Anne Arundel, Carroll, Howard, Queen Anne, St. Mary.	Dec. 25-Nov. 10.
Baltimore City (sale) (State law).	Dec. 25-Oct. 1.
Cecil	Feb. 1-Sept. 5.
Dorchester, Wicomico, Worcester (State law).	Feb. 1-Nov. 10.
Garrett, Harford	Dec. 1-Nov. 1.
Montgomery	Jan. 1-Sept. 1.
Prince George	Dec. 26-Nov. 9.
Somerset	Until Apr. 1, 1907.
Washington	Dec. 25-Aug. 12.
English pheasant, Mongolian pheasant, Dec. 25-Nov. 1 (except as follows):	
Anne Arundel, Howard	Dec. 25-Nov. 10.
Dorchester	To Apr. 1, 1907.
Garrett	Dec. 1-Nov. 1.[a]
Prince George	Dec. 26-Nov. 9.
Somerset, Wicomico, Worcester (State law).	Feb. 1-Nov. 10.
Wild turkey:	
Baltimore, Baltimore City (sale), Calvert, Caroline, Charles, Prince George, Talbot (State law).	Dec. 25-Nov. 1.
Allegany	Jan. 1-Oct. 15.
Dorchester, Somerset, Wicomico, Worcester[b] (State law).	Feb. 1.-Nov. 10.
Frederick	Jan. 15-Nov. 15.
Garrett	Dec. 1-Nov. 1.
Howard	Dec. 25-Nov. 10.
Kent	All the year.
Montgomery	Mar. 1-Nov. 1.
Washington	Jan. 1-Nov. 1.
Anne Arundel, Carroll, Cecil, Harford, Queen Anne, St. Mary.	Unprotected.
Dove, Dec. 25-Aug. 15 (except as follows):	
Carroll, Frederick, Wicomico.	All the year.
Kent	Dec. 25-Aug. 1.
Somerset	Jan. 16-Aug. 15.
Washington	Dec. 25-Aug. 12.
Wild pigeon, Kent County only.	Dec. 25-Aug. 1.
Woodcock:	
Baltimore, Baltimore City (sale), Calvert, Frederick, Howard (State law).	Dec. 25-Nov. 1.[c]
Allegany	Jan. 1-Oct. 15.[c]
Anne Arundel	Aug. 16-July 1.
Caroline	Jan. 16-July 4.
Carroll	Dec. 25-July 15.

Kinds of game.	Clo
Woodcock—Continued.	
Cecil	Jan.
Charles	Feb.
Dorchester	Jan.
Garrett	Dec.
Harford	Dec.
Kent	Dec.
Montgomery	Jan.
Prince George	Jan.
Queen Anne	Feb.
St. Mary	Feb.
Somerset	Jan.
Talbot	Jan.
Washington	Dec.
Wicomico	Feb.
Worcester	Feb.
Snipe, plover, May 1-Aug. 15 (except as follows):	
Anne Arundel	Aug.
Carroll	May
Kent, snipe (plover, Dec. 25-Aug. 1).	June
Prince George	May
Wicomico ("sandpiper," plover).	Jan.
Worcester	Unpr
Sora, water rail, or ortolan, Nov. 1-Sept. 1 (except as follows):	
Anne Arundel, Prince George (on marshes of Patapsco or Potomac).	Nov.
Patuxent River and marshes.	Jan.
Caroline	Jan.
Cecil	Feb.
Harford	Dec.
Talbot	Jan.
Reedbird, Nov. 1-Sept. 1 (except as follows):	
Cecil	Feb.
Harford	Dec.
Patuxent River and marshes.	Jan.
Duck (except wood duck), goose, brant, swan, and other wild fowl, Apr. 10-Nov. 1 (except as follows):	
Anne Arundel ("wild fowl" on Magothy, South, and Severn rivers).	May
Caroline (duck)	Apr.
Cecil, Harford, special local provisions.[a]	
Kent	Apr.
Patuxent River and marshes (duck and goose).	Apr.
Somerset (duck)	Apr.
Goose	Apr.
Talbot (wild fowl), on Great Choptank River.	May
Allegany	Unpr
Wood or summer duck, Apr. 10-Nov. 1 (except as follows):	
Charles (acorn duck), (State law).	Apr.
Dorchester	Dec.
Somerset	Jan 2
Talbot, Wicomico	Jan.
Worcester	Mar.

---

[a] According to an act passed in 1900, prohibiting the shooting of "any pheasant" season. If the term quoted applies only to ruffed grouse, the closed season for imported Dec. 25-Nov. 1, as fixed by the general State law.

[b] It is not clear whether or not the law protects the wild turkey in these counties.

[c] Except month of July, except in Baltimore County.

wise as stated in State law.

NORTH CAROLINA.

Close seasons for game under county laws.

ame.	Close seasons.
l (except as	
r............	Feb. 1-Oct. 1.
mbus,[b] Cur-	Jan. 1-Oct. 1.
....	Feb. 15-July 15.
ven, Jones ..	Feb. 1-Sept. 1.
....	Until Feb., 1907.
....	Jan. 1-Nov. 1.
l............	Mar. 1-Oct. 15.
kson, Scot- l.	Feb. 15-Aug. 15.
rson, Vance.	Jan. 15-Sept. 1.
v Hanover,	Jan. 1-Sept. 1.
....	Until Feb. 16, 1907.
....	Until Feb. 8, 1911.
....	Feb. 1-Nov. 1.
....	Feb. 1-July 15.
....	Until Mar. 2, 1908.
....	Until Mar. 9, 1908.
....	Dec. 1-Nov. 1.
nden, Cho- in, Edge- es, Greene, lyde, John- n, Onslow, , Perqui- Vashington, son.	Unprotected.
wan, Cleve- .[f] Gates, rg, Perqui- Wake.	Mar. 1-Nov. 1.
n, Tyrrell ...	Mar. 1-Oct. 15.
s, Pamlico, :.	Mar. 1-Oct. 1.
....	Mar. 1-Sept. 1.
....	Feb. 1-Sept. 1.
Pender	Apr. 1-Sept. 1.
nson, Cas- am, Frank- , Guilford, ecklenburg, nge, Wake,	Feb. 1-Oct. 1.
....	Feb. 1-Sept. 1.
oln.........	Jan. 1-Oct. 1.
....	Mar. 1-Oct. 1.
ge, Mar. 15- as follows):	
....	Jan. 15-Dec. 1.
auga[h].......	Mar. 15-Nov. 1.
rtie, Bruns- den, Chat- n, Currituck, e, Halifax, v Hanover, Richmond,	Mar. 1-Nov. 1.

Kinds of game.	Close seasons.
Quail or partridge, Mar. 15-Nov. 1, etc.—Continued.	
Buncombe [i], Lincoln, Surry.	Feb. 1-Dec. 1.
Burke, Nash, Northampton.	Feb. 1-Nov. 1.
Cabarrus, Cherokee, Davidson, Edgecombe, Macon, Montgomery, Randolph,[j] Wilson.	Mar. 1-Nov. 15.
Catawba, Forsyth, Iredell, Rowan.[k]	Feb. 15-Nov. 15.
Clay, Davie..............	Mar. 1-Dec. 1.
Dare, Tyrrell............	Mar. 1-Oct. 15.
Gaston,[l] Mecklenburg ...	Jan. 10-Dec. 1.
Henderson..............	Apr. 1-Nov. 15.
Hyde....................	Mar. 20-Oct. 15.
Pasquotank, Perquimans.	Mar. 1-Nov. 20.
Scotland	Apr. 1-Oct. 15.
Swain...................	Jan. 1-Nov. 20.
Union..................	Jan. 15-Dec. 15.
Vance...................	Mar. 15-Oct. 15.
Carteret, Columbus, Graham, Onslow.	Unprotected.
Pheasant:	
Anson (Lanesboro township).	Jan. 20-Nov. 20.
Buncombe,[i] Rowan......	Feb. 1-Dec. 1.
Burke....................	Feb. 1-Nov. 1.
Cherokee, Edgecombe, Macon.	Mar. 1-Nov. 15.
Clay.....................	Mar. 1-Dec. 1.
Currituck	Until Apr. 1, 1906.
Granville................	Mar. 1-Nov. 1.
Henderson..............	Apr. 1-Nov. 15.
Randolph (Columbia township).[m]	Jan. 1-Dec. 1.
Swain...................	Jan. 1-Nov. 20.
Wild turkey, Mar. 15-Nov. 1 (except as follows):	
Anson,[g] Rowan[k].........	Mar. 15-Nov. 1.
Bertie, Chatham, Craven, Granville, Halifax, Jones, New Hanover, Warren.	Mar. 1-Nov. 1.
Buncombe,[i] Clay, Randolph.[e]	Feb. 1-Dec. 1.
Cabarrus, Cherokee, Davidson, Edgecombe, Macon, Montgomery, Wilson.	Mar. 1-Nov. 15.
Davie....................	Until Mar. 1, 1908.
Henderson..............	Apr. 1-Nov. 15.
Martin..................	May 1-Jan. 1.
Mecklenburg............	Feb. 1-Nov. 15.
Northampton............	Feb. 1-Nov. 1.
Pamlico.................	Mar. 1-Sept. 1.
Pender..................	Feb. 1-Oct. 1.
Richmond...............	Jan. 1-Oct. 1.
Scotland	Apr. 1-Oct. 15.
Stanly..................	All the year.
Union...................	Mar. 15-Nov. 15.

arver Creek and White Creek townships, Dec. 1-Nov. 1.
e Waccamaw only.
North River side of Poplar Branch Township, Mar. 1-Sept. 21.
eras Banks to Mar. 4, 1908.
olumbia Township, Jan. 1-Dec. 1.
squirrel on Hatteras Banks to Mar. 4, 1908.
anesboro Township, Jan. 20-Nov. 20.
ove Creek Township, all the year.
eicester Township, to Mar. 2, 1908.
ranklinsville Township, Jan. 1-Dec. 1.
leveland, Morgan, Scotch-Irish, and Steele townships, Dec. 1-Mar. 1.
herryville, Crowder-Mountain, and Gastonia townships o Mar. 4, 1910.
orted pheasants in whole county, Dec. 15-Nov. 14.

NORTH CAROLINA—Continued.

Close seasons for game under county laws—Continued.

Kinds of game.	Close seasons.
Wild turkey, etc.—Cont'd.	
Vance	Mar. 15-Oct. 15.
Carteret, Columbus, Cumberland, Dare, Duplin, Graham, Onslow, Swain, Tyrrell.	Unprotected.
Dove, Mar. 15-Nov. 1 (except as follows):	
Anson,[a] Gaston,[b] Randolph.[c] Rowan.[d]	Mar. 15-Nov. 1.
Beaufort	Mar. 20-Oct. 15.
Bertie, Brunswick, Craven, Granville, Jones, New Hanover.	Mar. 1-Nov. 1.
Buncombe[e]	Feb. 1-Dec. 1.
Cabarrus	Mar. 15-Nov. 15.
Cherokee, Edgecombe, Macon, Montgomery.	Mar. 1-Nov. 15.
Davidson, Richmond, Scotland.	Apr. 1-Oct. 15.
Davie	Mar. 1-Dec. 1.
Halifax, Warren	Feb. 1-Aug. 1.
Henderson	All the year.
Mecklenburg	Feb. 1-Nov. 15.
Vance	Mar. 15-Oct. 15.
Carteret, Clay, Columbus, Cumberland, Dare, Duplin, Graham, Hyde, Moore, Onslow, Pamlico, Swain, Tyrrell, Wilson.	Unprotected.
Woodcock:	
Anson (Lanesboro township).	Jan. 20-Nov. 20.
Brunswick, New Hanover,	Jan. 1-Sept. 1.
Cherokee, Edgecombe, Randolph.[f]	Mar. 1-Nov. 15.
Craven, Jones	Feb. 1-Nov. 1.
Granville	Mar. 1-Nov. 1.
Woodcock—Continued.	
Henderson	All the yea
Rowan (Cleveland, Morgan, Scotch Irish, and Steele townships).	Feb. 1-Dec.
Snipe:	
Anson (Lanesboro township).	Jan. 20-No
Brunswick, New Hanover.	Mar. 1-Sep
Cherokee, Edgecombe	Mar. 1-No
Granville	Mar. 1-No
Halifax, Warren	May 1-Feb.
Henderson	All the yea
Randolph (Columbia Township).	Jan. 1-Dec.
Marsh hen, curlew, and other shore birds:	
Anson (Lanesboro Township).	Jan. 20-No
Cherokee, Henderson	All the yea
Edgecombe	Mar. 1-No
Granville	Mar. 1-No
New Hanover	Apr. 1-Sep
Wild fowl:	
Anson (Lanesboro Township).	Jan. 20-No
Brunswick, New Hanover (except duck, Mar. 1-Sept. 1).	Mar. 10-No
Carteret (Bogue Banks only).	Apr. 1-Dec.
Cherokee, Henderson	All the yea
Craven, Granville, Jones.	Mar. 1-No
Currituck	Apr. 1-No
Edgecombe	Mar. 1-No
Randolph (Columbia Township only).	Jan. 1-Dec.
Wilson (Black Creek only)	Apr. 1-Oct.

---

[a] In Lanesboro Township, Jan. 20-Nov. 20.

[b] In Cherryville, Crowder Mountain, and Gastonia townships to Mar. 4, 1910.

[c] In Columbia Township, Jan. 1-Dec. 1.

[d] In Cleveland, Morgan, Scotch-Irish, and Steele townships, Dec. 1-Mar. 1.

[e] In Leicester Township, to Mar. 2, 1908.

[f] In Columbia township, Jan. 1-Dec. 1.

[g] Dates fixed by chap. 291, Laws of 1897, chap. 245, Laws of 1899, and chap. 112, Laws of 190 1899 law (chap. 245) has a provision which has not been repealed or amended, that apparent the prohibition to shooting over decoys in Currituck Sound.

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No. 50. Sorghum as a Forage Crop. No. 51. Standard Varieties of Chickens. No. 52. The
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57. Butter Making on the Farm. No. 58. The Soy Bean as a Forage Crop. No. 59. Bee Ke
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No. 66. Meadows and Pastures. No. 68. The Black Rot of the Cabbage. No. 69. Experim
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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 231.

PRAYING FOR CUCUMBER AND MELON DISEASES.

BY

W. A. ORTON,

Pathologist, Vegetable Pathological and Physiological Investigations,
Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., August 15, 1905.

Sir: I have the honor to transmit herewith an article entitled "Spraying for Cucumber and Melon Diseases," by Mr. W. A. Orton, Pathologist, and recommend its publication as a Farmers' Bulletin.

This paper was submitted, with a view to publication, by Mr. A. F. Woods, Pathologist and Physiologist of this Bureau. It is for the most part the result of experiments conducted during 1904 and 1905, in cooperation with the South Carolina Agricultural Experiment Station, at Charleston, S. C., to control the downy mildew. An account of these experiments, with other matters of local interest, is also to be published by the South Carolina station.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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FIG. 1. Cucumber leaf attacked by downy mildew
2. Cantaloupe leaves showing effect of leaf-blight
3. Cucumber leaf attacked by anthracnose
4. Hand barrel sprayer, with cart, in operation in a cucumber field
5. Front view of machine sprayer
6. Spraying three rows of cucumbers with machine sprayer
7. Diagram showing arrangement of row sprayer on machine
8. Platform for loading machine sprayer

SPRAYING FOR CUCUMBER AND MELON DISEASES.

INTRODUCTION.

The purpose of this bulletin is to describe briefly the common diseases of cucurbits and to state the practical requirements for their control. Since adequate apparatus must be available before spraying can be generally practiced, the essential points of a good sprayer are described in detail.

It should be emphasized that success in spraying is a question of methods. It depends absolutely upon intelligent oversight, suitable apparatus, and thorough application. All the failures investigated have been due to errors in methods or lack of thoroughness.

DESCRIPTIONS OF DISEASES.

Several diseases attack the leaves of cucumbers and melons in this country. Downy mildew, leaf-blight, and anthracnose are the most common, though there are several others of less importance. The parasitic fungi which cause these troubles are quite distinct in their nature, but produce rather similar effects on the foliage. From the standpoint of the farmer they may be considered together, since the treatment for all is practically the same. It is well to know their exact characters, however, especially since there are a number of other maladies, due to bacteria, soil and climatic conditions, and to insects, which do not yield so readily to spraying, and may be confused with the diseases to be described.

DOWNY MILDEW.

Peronoplasmopara cubensis (B. & C.) Clint.

Downy mildew, the most destructive of all cucurbit diseases, is especially injurious to cucumbers, but also attacks melons, squashes, pumpkins, gourds, and other related vines.

Appearance.—The first indication of downy mildew in the field is a yellowing of the older leaves in the center of the plant. Faintly defined angular spots bordered by the veins will then be detected (fig. 1). These become more distinct, and if the weather is r obscure violet coating of the spores may be noticed on the un of the spots. The disease progresses from the center of the ward, the young leaves at the tips of the branches living It spreads slowly in bright weather, but under the more f conditions afforded by cloudy, humid weather it often develc the greatest rapidity, so that the fields quickly become as if by fire.

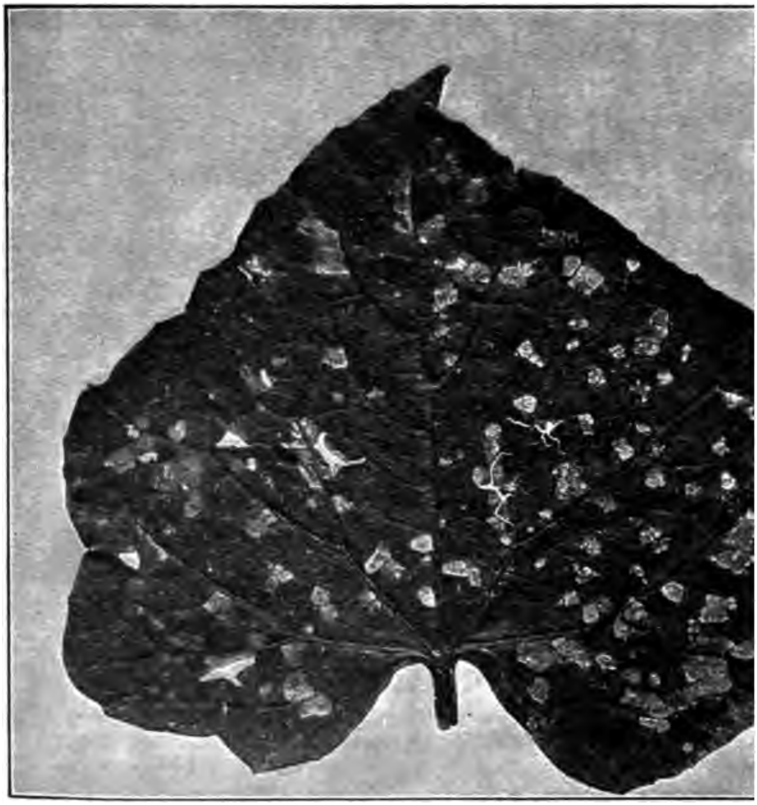

FIG. 1.—Cucumber leaf attacked by downy mildew.

Downy mildew has been known in this country since 1889 various years has caused serious loss, especially to the pickle i on Long Island and in Ohio and other States. It is also destr cucumbers in greenhouses.

Cause.—Downy mildew is caused by a parasitic fungus related to the destructive downy mildews of grape, onion, etc the late blight of potato. So far as known, it is spread entirel conidia, or summer spores, produced on the lower surface of leaves. These are blown about by the wind, but are very thin licate bodies, which perish quickly when dried. No oospore or sting stage is known, and there is consequently no evidence that the ungus lives over in dead vines or in the soil, and no logical reason r destroying the vines or for selecting fresh land for the crop, ide from questions of soil fertility.

Conditions favoring development.—The disease lives through the inter in Florida and probably spreads northward each summer. here is also good evidence that it lives over in greenhouses, which ay later become the centers of local epidemics.

The earliest appearance of the disease in South Carolina in 1905 as May 1. It usually appears in that latitude during June. It does t reach Ohio until August 1, while New York and New England e visited later in August. The date of appearance and the severity the outbreak seem to be governed mainly by the weather. During usually dry seasons the disease may be entirely absent, while rmth and moisture, especially warm, cloudy nights, soon lead to development and result in the greatest loss. Any weakness of the ant appears also to predispose it to attacks of downy mildew. ld weather during spring, when the plants are small, is unfavorle for this reason. The plant also becomes more susceptible when e bearing of fruit is imposing an additional strain upon it. Liberal rtilizing and careful attention to cultivation should be given to ep the vines strong and vigorous.

LEAF-BLIGHT.

Alternaria brassicæ nigrescens Pegl.

The above-named fungus is the usual cause of leaf-blight of muskelons or cantaloupes throughout the country, though downy mildew nd anthracnose also occur and sometimes are associated with the af-blight.

Appearance.—Leaf-blight begins in small, round spots, which usully show faint concentric rings. These spots enlarge and their ffect is very quickly visible on the leaf. The cantaloupe leaf in articular, owing to its thin and delicate structure, will curl at the nargins and shrivel up in a few days. (See fig. 2).

Cause.—The disease is caused by a fungus closely related to the pecies causing early blight of potato, leaf-blight of cabbage, etc. It was first studied in this country by Dr. Erwin F. Smith in 1892. The same year it was described from Italy by Peglion as *Alternaria brassicæ*, var. *nigrescens*. Later the same fungus was named *Macrosporium cucumerinum* by Ellis and Everhart, and has been referred to under this name in several experiment station bulletins.

Leaf-blight is spread by spores borne on the upper side of the eaves and carried by the wind and the other [illegible] No perfect stage has been discovered, but it is probable that the fungus lives over winter in the fields, and the experience of farmers indicates that it is worse on fields repeatedly planted in melons. Rotation of crops is therefore advisable to lessen its ravages. This disease does not, as a rule, develop in the field as rapidly as the downy mildew, but in warm, humid weather it spreads quickly and does great harm. The ripening of the melons is hastened, their quality greatly injured, and the total crop diminished.

ANTHRACNOSE.

Anthracnose occurs on the leaves and stems of cucumbers and muskmelons, and on the leaves, stems, and fruits of watermelons. It also attacks other cucurbits. It is common and sometimes injurious, but is relatively of less importance than the downy mildew or the leaf-blight.

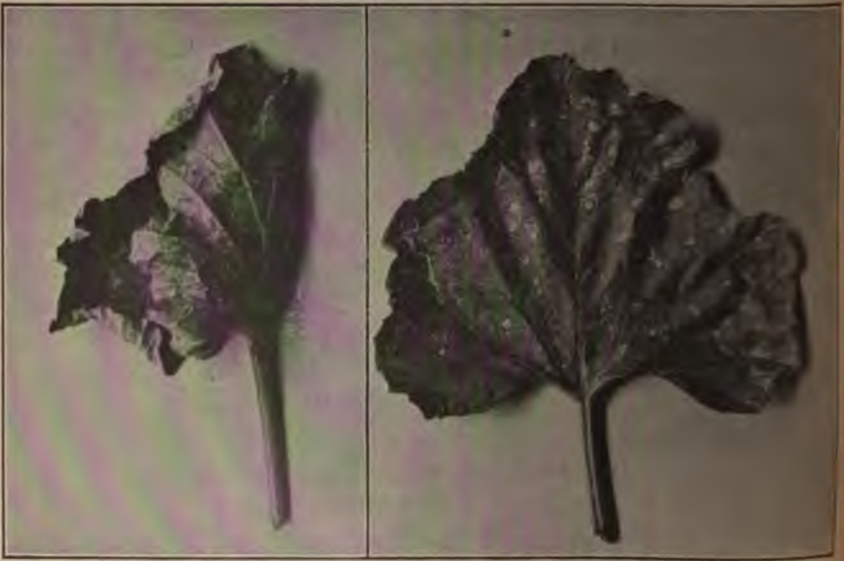

FIG. 2.—Cantaloupe leaves showing effect of leaf-blight.

Appearance.—Circular dead spots from one-fourth to one-half inch in diameter are formed on the leaves (fig. 3). They are distinguishable from the angular spots of the downy mildew, except when the latter have grown very slowly. On the stems anthracnose causes elongated, discolored, and shrunken areas, which finally lead to the death of the branch. Watermelon fruits are often badly spotted by this disease, and much injury is done to the vines.

Cause.—Anthracnose is due to the fungus *Colletotrichum lagenarium* (Pass.) Ell. & Hals., which is related to the fungi causing ıose in grapes, raspberries, cotton, and beans, and the bitter ıe apple. It is spread freely by the conidiospores which are 1 in abundance in the spots on the leaves and fruit. A perfect not known, but the field evidence indicates that the disease in the dead vines or elsewhere in old fields, and the destruc-

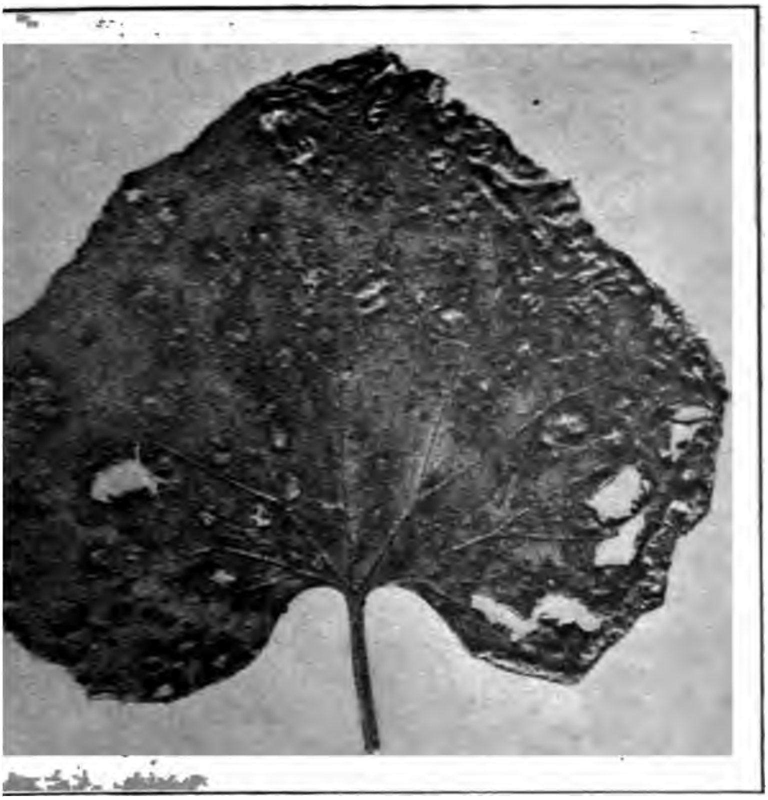

FIG. 3.- Cucumber leaf attacked by anthracnose.

such vines, together with rotation of crops, is recommended ·ans of prevention.

OTHER LEAF-SPOT DISEASES.

three fungi previously mentioned are the most common and us cucurbit pests, but several minor troubles occur and cause losses, which could be prevented by spraying. They hardly · separate mention in a publication of this character, as it be difficult for the practical grower to distinguish them. The causing them are *Phyllosticta cucurbitacearum* Sacc., *Clado-* *n cucumerinum* Ell. & Arth., *Acremonium* sp., and *Cercospora* *ına* Cke. The powdery mildew of the cucumber, *Erysiphe* *ni* DC., is common in greenhouses, but infrequent outdoors.

It forms a powdery white coating on the leaves without causing a spot, and is thus easily distinguished from the downy mildew.

Other troubles encountered in the field and greenhouse are stigmonose, due to an attack of aphides; wilt and leaf-curl, due to overfertilizing, etc., and root-knot, caused by nematodes.

WILT.

There is a form of wilt sometimes met with in greenhouses which is due to overfertilizing.

Another distinct cucurbit disease is prevalent in the North and West, and is mentioned to avoid confusion with the leaf-blights already described. When a melon, cucumber, or squash vine suddenly wilts throughout its length and dies without appreciable spotting of the leaves the trouble is usually caused by a species of bacteria, *Bacillus tracheiphilus* Erw. Sm., which enters and clogs the water-carrying vessels of the stem. This wilt disease is spread by leaf-eating insects and probably also by soil infection. Rotation of crops is advised, together with the addition of an insecticide like Paris green to the Bordeaux mixture. The Bordeaux mixture itself acts as a repellant to the insects and helps to check the spread of wilt. There is experimental evidence showing the value of spraying for wilt, but it should not be expected that this disease will be as fully controlled in this way as the leaf-blights. It is also important to pull and burn diseased vines as soon as they begin to wilt, in order to lessen the spread of the disease.

Fusarium wilt.—Another wilt disease of cucumbers and muskmelons similar in appearance to that described in the preceding paragraph is due not to bacteria, but to a fungus related to the one causing the watermelon wilt, *Neocosmospora vasinfecta*, var. *nivea*. This disease has been little studied, and is apparently not of great importance. Spraying will not prevent this form of wilt, and rotation of crops is essential.

DISEASE RESISTANCE.

The possibility of securing strains or varieties of cucumbers and melons resistant to the leaf-blight fungi has been considered and some experiments have been made. In connection with experiments recently made at Charleston, S. C., all obtainable varieties of cucumbers and muskmelons were planted and left unsprayed to determine their relative susceptibility. All were attacked, and while differences in degree of infection were noted, all were badly injured. One kind of cucumber, the Japanese climbing variety, was more resistant than the others and remained living after they were dead. There is little doubt that well-directed efforts in plant breeding would result in the lopment of resistant or partially resistant strains. This would ire several years of effort. The market requirements are for par- ar types of fruits, and a disease-resistant strain would have to orm to these demands. While it is very important that efforts ld be made to develop such desirable qualities, it appears that tance to leaf-blights among cucurbits is at present so slight as nount to very little and that spraying must be the main protection le farmer.

SPRAYING EXPERIMENTS.

ıat diseases of cucumbers and melons can be controlled by spray- with Bordeaux mixture has been successfully demonstrated by ·al investigators during recent years. The first recorded ex- nents were made by Col. A. W. Pearson in 1888 and 1889 under direction of the Department of Agriculture, using Bordeaux ure for melon blight, but without definite results. Dr. B. D. ted, of the New Jersey Experiment Station, conducted a series nnual experiments, beginning in 1894, which showed the effi- y of Bordeaux mixture and later of soda-Bordeaux mixture nst downy mildew and anthracnose of cucumbers.

of. F. C. Stewart, of the New York State Experiment Station, ucted field experiments with cucumbers on a more extensive scale ong Island in 1896, 1897, and 1898, using Bordeaux mixture to ol the downy mildew. He showed the first year that by an ex- iture of $9.50 per acre there was an increased net profit of $163.50 acre due to protection from disease, the cucumbers produced sold for pickles. The experiments of the two following years borated these results, and the Long Island growers have since continued spraying as a regular practice.

of. A. D. Selby, of the Ohio Experiment Station, conducted ex- nents along the same line in 1897 and 1898. He showed that co- ative spraying experiments gave an increase of 75 bushels per of cucumbers for pickling over unsprayed vines attacked by ay mildew. Anthracnose and other leaf-blights were also con- ed in most cases.

. W. C. Sturgis, at the Connecticut State Experiment Station, yed muskmelons in 1898 with complete success in controlling leaf- its, though the bacterial wilt did not yield to the treatment.

r. H. H. Griffin, of the Colorado Experiment Station, conducted ying experiments on cantaloupes at Rockyford in 1899, 1900, and with uniform success in controlling the leaf-blight with Bor- x mixture. The average cost per acre was $4.47 in one instance, less in others.

of. H. H. Hume, at the Florida Experiment Station, sprayed 00 for the downy mildew of the cucumber with success.

Prof. G. P. Clinton, at the Connecticut State Experiment Station. conducted experiments in 1902 and 1903 which led him to the following conclusions:

> (1) When the downy mildew is very severe, spraying is useless; (2) when the seasons are cold and damp but fungi not usually destructive, spraying may show some benefit to the foliage, but the unfavorable influence of the weather will not be overcome by this treatment; (3) warm, fairly dry seasons (moisture well distributed) are necessary for the best development of muskmelons in Connecticut, and such seasons are not likely to bring serious attacks of fungi, so that spraying in these seasons is of little or no advantage; (4) everything considered, spraying muskmelons scarcely merits recommendation in this State. These statements do not apply to the cucumber, which, without doubt, is often benefited by thorough spraying.

Mr. E. R. Bennett, at the Connecticut (Storrs) Experiment Station, performed similar experiments in 1903, which were successful in controlling the downy mildew.

The extensive field experiments conducted by this Department at Charleston, S. C., upon which the recommendations in this bulletin are based, showed that downy mildew of the cucumber can be controlled even during a most unfavorable season when the work is done with sufficient thoroughness.

PRACTICAL CONCLUSIONS RELATIVE TO METHODS OF SPRAYING.

MANNER OF PLANTING.

It is of great importance for economy of time and labor in spraying to adjust the rows in planting so as to facilitate the use of spraying machinery. This is particularly necessary when the acreage is large and geared sprayers are to be used.. Distances in planting are often matters of local custom that might be modified without loss. The rule should be to plant in long rows with single vines at close intervals in the row, rather than in hills. Cucumbers, for instance, are planted in the South in rows 6 feet apart, with the vines 18 inches apart in the row. Cantaloupes or muskmelons would require about 24-inch spaces in 6-foot rows. During cultivation the vines should be encouraged to spread along the rows, and by the use of a vine turner an open alley 1 foot wide can be preserved throughout the season. This will allow the sprayer to be driven through the field and will also permit the passage of the pickers with less injury than when the vines are planted in hills. If the wheels of the sprayer occasionally nip off the ends of branches that have straggled across the path, the loss is insignificant when compared with the benefit derived from spraying.

At the ends of the rows space must be left to turn the sprayer. T reduce this wasted area and to save time in turning, the rows shou be as long as possible.

sprayers are usually made with 6-foot axles to cover one
nes or two rows of potatoes. In special cases, as when the
ed has a width of less than 6 feet, the distance between the
uld be made to correspond. If, for instance, the outfit is
nted on a barrel carried in a farm wagon and the spray dis-
through long hose, a roadway may be left at every eighth
row to permit the passage of the wagon, and this space may
d, as suggested by Stewart, with cabbages or other low
s a matter of field practice, however, it would be as well
his roadway with melons or cucumbers like the rest of the
keep them in a narrow bed. The hill or check system of
involves either the use of hand sprayers or greater injury
nes. Intercultural crops, such as beans planted between
f cucumbers, are objectionable when spraying is to be done,
inder the use of the spray cart and may also be injured by
aux mixture.

EQUIPMENT.

aracter of the apparatus required for spraying vine crops
upon the area to be sprayed. It may be classified for our
n under three heads, viz, equipment for gardens, for small
d for large fields.

Garden Sprayers.

less than an acre of vines is to be sprayed, a small hand
signed to spray from a bucket is all that is needed. Modi-
of this are on the market, with the pump mounted in a cov-
ket to be carried in the hand, or as a knapsack sprayer,
erhaps the most convenient form of small pump for general
ood compressed-air sprayer serves much the same purpose
ost. Nearly all of the sprayers found on the market would
ved by lengthening the hose to 6 feet or more. The nozzle
of the Vermorel type.

Field Sprayers.

lds of from 1 to 5 acres a barrel sprayer is recommended.
sists of a hand pump mounted in a barrel or tank and
with two leads of ⅜-inch hose 25 feet long, each with
extension made from ¼-inch gas pipe, and a double Ver-
zzle. The barrel should be mounted on a two-wheeled
ng a 6-foot axle. Two horses are required when driving
s in 6-foot rows. Three men do the work. One is expected
and pump, while the other two manipulate the nozzles.
t is stopped while the vines within reach are sprayed, then
rward about 30 feet and stopped again. On an average

in actual field practice 3 to 4 acres per day can be sprayed
way, applying 200 gallons of Bordeaux mixture per acre. T
the long hose off the vines two poles about 10 feet long r
pivoted to the bed of the cart so as to swing at an angle o
wheel and carry the hose, as shown in figure 4. The pump f
outfit should be of good capacity, with brass valves. A "Y
off discharge connection on the pump is a convenience for st
the spray at any time. Carts of this kind are usually homema
they are on sale by some dealers. The evener and neck yoke
be 6 feet long, except that early in the season when the vi
small it will be found that the ordinary length can be used to
advantage. This outfit is excellently adapted for spraying

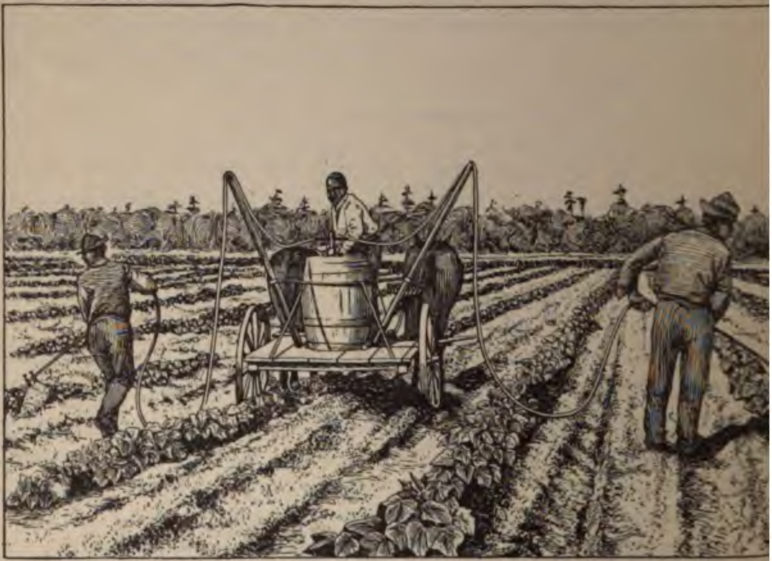

FIG. 4.—Hand barrel sprayer, with cart, in operation in a cucumber field.

fields of potatoes and for general orchard work, and is inva
on the average farm. Instead of using a special cart some
prefer to set the barrel in an ordinary farm wagon or to mo
on a pair of low wheels and push it about by hand.

Geared Sprayers.

When there are more than 5 to 10 acres of vine crops and po
to be sprayed a suitable horsepower sprayer will, by econor
time and labor, considerably reduce the cost per acre and, if pro
constructed and operated, will do more efficient work than
labor. The saving of labor on a large truck farm, for instan
especially important, as field work is usually done under the
pressure incident to the cultivation and shipment of strawb

beans, beets, cabbages, potatoes, etc., during the cucumber season. Reliable laborers are scarce, and the power sprayer will permit one man to do four to five times the work of three men and a hand pump by covering 15 acres per day instead of 3 or 4 acres. The time saved is equally valuable, as spraying must often be done at intervals between other duties, and in case of continued rainy weather the ability to spray the whole field promptly may mean the preservation of the crop. Less Bordeaux mixture is consumed by a power sprayer. One hundred gallons per acre should be applied, and this will cover every leaf with a fine mist in an ideal manner, while the hand sprayer operated by the average laborer will require 200 gallons per acre, owing to the excess applied to some leaves in order to insure reaching all. Experience has also shown that with hand labor there are occasional vines entirely overlooked, and that, on the whole, machine work is more effective. This should not be interpreted to mean that all geared sprayers would be so effective. Many machines on the market have been developed for applying arsenites to potatoes and are not adapted for putting Bordeaux mixture on cucumbers or melons. The primary requisite of a sprayer for the latter purpose should be the [illegible]bility to apply 100 gallons of Bordeaux mixture per acre through [illegible]rmorel nozzles. No machine with a capacity of only 25 to 50 [illegible]llons per acre can be expected to protect tender vines from such [illegible]ctively parasitic fungi as those which attack cucurbits, for it is impossible to make so small a quantity of solution cover every part of every leaf. Many other points affecting durability of construction [illegible]d ease of operation are also important, and each of these will be [illegible]cussed in turn. The writer is not aware that there is now on the [illegible]rket any power sprayer especially fitted for vine crops. The pur[illegible]haser will usually be obliged to purchase a potato sprayer and have such modifications made as may be required. A suitable outfit will consist of a two-wheel two-horse cart, with a 6-foot axle, carrying a 100-gallon tank, with double-cylinder pump, operated from the axle by sprocket chain; air chamber; agitator; and row sprayer for 2 rows of cucumbers or 6 rows of potatoes. (See fig. 5.) The parts are discussed in detail as follows:

Pump.—A pump with double vertical cylinders, or its equivalent in other styles, is advised. A large capacity is essential. All working parts should be of brass or bronze, including valves, which should be easily accessible. A hand lever, though rarely used on a field sprayer, is occasionally convenient.

Air chamber.—The air chamber should be of good size, but not too [illegible]rge, as liquid and sediment will tend to accumulate in it. Provision [illegible]ould be made for draining and cleaning the air chamber.

Pressure gauge.—A high pressure, 40 to 100 pounds, is required to [illegible]complish best results in spraying. A pressure gauge connected with the air chamber is therefore essential in order that the operat may know what his machine is doing, and also to reduce the dang of an explosion from too much pressure.

By-pass.—Every power sprayer must be fitted with a by-pass, safety valve, arranged so that the liquid will be discharged bac into the tank whenever the pressure reaches a given point. Atte tion should be paid to this device to see that it is properly adjusted.

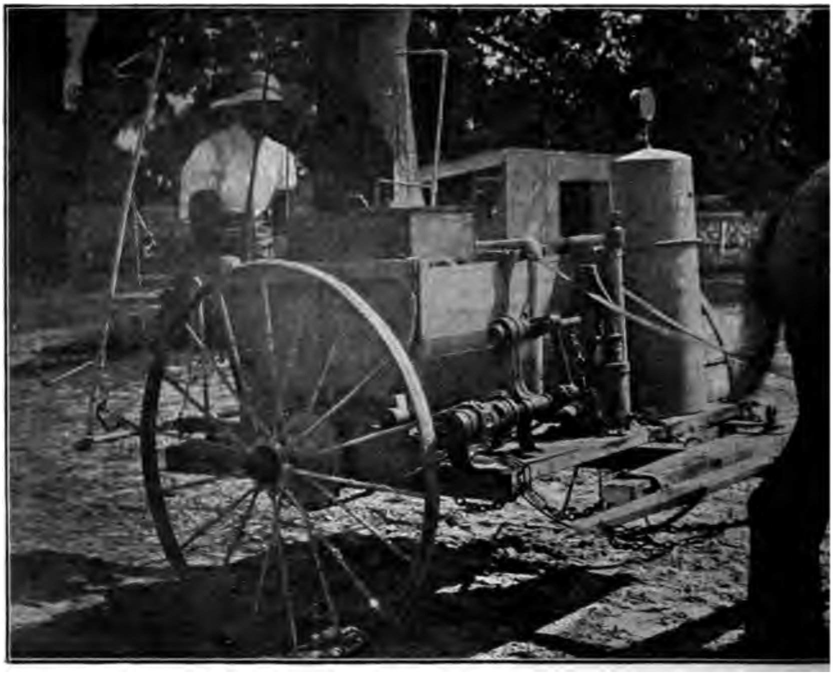

FIG. 5.—Front view of machine sprayer.

Piping.—The best sprayers are equipped with brass piping, becau iron is rapidly corroded by the copper compounds used in sprayin and the flakes from the inside of the pipe are likely to clog the no zles. On the other hand, iron pipe is much cheaper, and if the outfi is washed out after each using there is little trouble during th spraying season. Iron pipes are likely to rust rapidly and fill wit sediment when not in use, and a sprayer should never be used in th spring until all the pipes have been taken apart and thoroughly cleaned inside. It costs very little to replace iron piping, and the use of brass, though preferred, is therefore not essential.

Row sprayer.—This refers to the device employed to hold the spray nozzles over the rows to be sprayed, including the pipes leading from the discharge pipe to the nozzles. Rubber hose is sometimes emd for the latter purpose, but in most cases an iron pipe attached e rear of the platform and extending laterally over the rows ther side carries the nozzles at the ends of arms of the proper h. (See fig. 6.) The main pipe is three-fourths inch in the cen- educed to one-half inch, and again to three-eighths inch on either Joints behind each wheel, made by inserting two elbows and ple, allow the extending ends to be folded up when driving to from the field. For spraying potatoes it is sufficient to attach nozzles directly to this pipe so that they point back and down, for vine crops, where the rows are wide and the spread of the variable at different periods and in different fields, it is necessary rovide for adjusting the nozzles so as to spray either a narrow at the beginning or the whole space at the end of the season. s may be accomplished by placing the nozzle on an extension made n two sections of one-fourth-inch pipe 6 to 8 inches long, united hinge joint. This hinge may be made from two iron elbows and ipple, but it is much better to have a brass swivel joint, secured a thumbscrew, as shown in figure 7. Additional adjustments can made at the nozzle. The length of the arm (*a*, fig. 7) allows the ter nozzles to be elevated to cover a wide row, which is important en cucumbers are grown on a high ridge or bed. Three rows of es are covered at one time, and each row receives the spray from ove and from either side. The nozzles at the side should be car- d nearer the ground and directed sideways. In this way much of e spray will reach the under sides of the leaves.

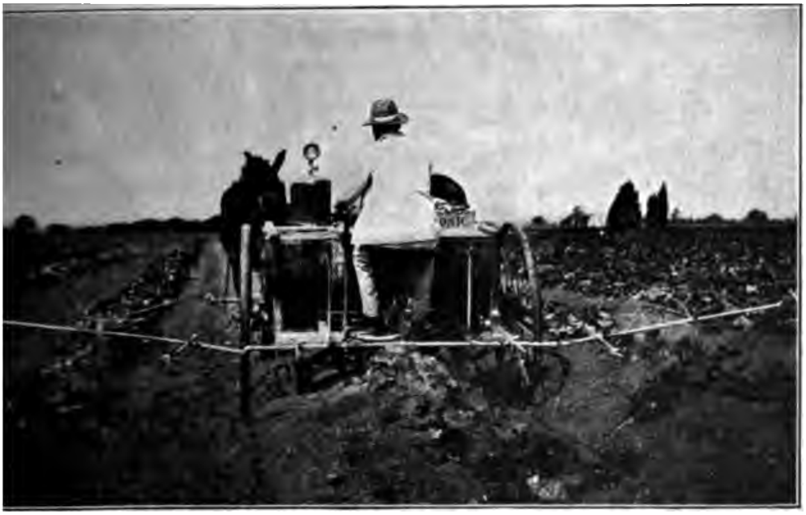

FIG. 6.—Spraying three rows of cucumbers with machine sprayer.

The row sprayer is usually fixed immovably to the platform
cart. This was found to be a serious objection in spraying c
bers, as the nozzles were thrown off the rows whenever the cou
the machine varied from a straight line, which was rather oft
irregular ground early in the season. The same thing occur
turning at the ends of the rows and when operating on windy
To obviate this difficulty, the device illustrated in figure 7 was att
to allow the whole row sprayer to be moved from side to side
will of the operator. This was accomplished by a wooden
(*a-b-c-d*), pivoted to the rear platform at *e-e* and supportin
row sprayer by iron clamps at *a* and *d*. The foot lever *f-f* i

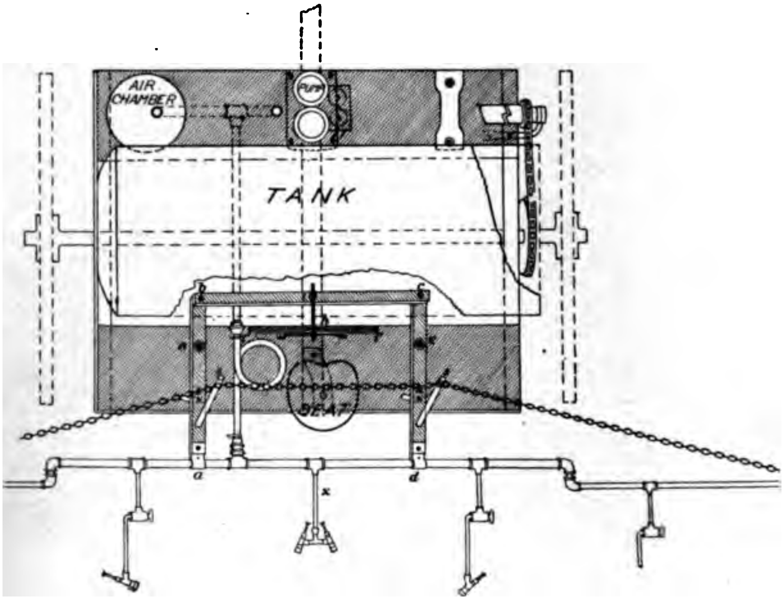

FIG. 7.—Diagram showing arrangement of row sprayer on machine.

vated by an iron brace from the platform, and the rigid iron p
tion (*h*) passes through an eyebolt in the wooden bar *b-c* at *i*.
the team swerves to the left, the driver, by pressing the lever wi
right foot, moves the row sprayer to the right and brings the n
again over the row. Rollers at *k-k* relieve the friction of the
on the platform, and little force is required to move it. To u
iron standards made from one-fourth-inch gas pipe (*s-s*) a
jack chain is attached to support the ends of the row sprayer.
chains are within the reach of the driver on the seat in case th
must be raised to pass over an obstacle or through a gateway.
device for securing lateral movement of the row sprayer is not
lutely essential, but is simple in construction and adds to the effi
the outfit. This is particularly the case on windy days

the entire spray is blown to one side, as it is easy to overcome what would otherwise be an insurmountable difficulty by throwing the row sprayer to windward. On turning at the end of the row it is quickly thrown over to the other side. This device is not patented, but has been in use two years.

Nozzles.—The best results were obtained by using 6 nozzles to the row, 2 over the center and 2 on each side. Three nozzles might suffice for young vines, but less than this number would never do thorough work, and when the vines cover the ground 6 to the row is not too many. As far as possible the nozzles should be set at different angles, pointing forward, back, and sideways, so that their spray does not meet. The vines will then be struck from every direction, and no portions of them can escape the treatment. A fine spray is desired for this work, and nozzles of the Vermorel type are best.

Spray cart.—This consists of a plain iron and wood frame, balanced on an axle 6 feet long. The wheels should be fairly high and very strong, with wide tires. The gearing should be arranged to draw from both wheels and should be simple in construction and strong. The fact that a spray cart must be driven very slowly should be borne in mind, and the pump should therefore be geared relatively high. The weight of a man on the seat should balance the load. Two horses are required. The evener and neck yoke should be 6 feet long, except early in the season, when the ordinary length is preferable, as the team will keep a straighter course when driven close to the beds.

Tank.—The best size of tank is one capable of holding 100 gallons. A larger one is heavy for two wheels and a smaller size requires too frequent filling. The form of tank is less important, but the half-round style is preferable to the upright. The best tanks are of cypress and those especially constructed for the purpose can be found in the market.

Agitator.—A mechanical agitator is provided with the best outfits. It should not be of iron unless thickly covered with asphalt paint, and it should work easily.

Strainer.—A good strainer is indispensable, as much clogging of the nozzles follows if any large particles are admitted to the spray tank. The most convenient form for a large tank is V-shaped, set permanently into the tank under the lid. The strainer should be large, with at least 1 square foot of surface. Brass-wire cloth, 18 meshes to the inch, is the best material. For barrel sprayers use a similar V-shaped strainer set in a wooden box, into the bottom of which a short section of 2-inch iron pipe is screwed for an outlet. It will be a further convenience if a second strainer of coarser mesh is provided for straining the stock lime into the dilution [illegible]

ADAPTING POTATO SPRAYERS TO VINE CROPS.

Most of those who prepare to spray as directed in this bulletin will find it desirable to use machines made primarily for potatoes. This can usually be done by a change in the row sprayer, provided that the pump is of sufficient capacity to do the work. The sprayer must apply at least 100 gallons per acre through Vermorel nozzles. One that will apply 50 gallons per acre could be run twice over the same field. There is always a tendency, however, on the part of workmen to do superficial spraying. To do good spraying, a very slow-walking team should be chosen, and the pump should be geared correspondingly high so as to maintain full pressure at a slow speed. Few potato sprayers will work when driven slowly, on account of a lack of pressure. On the other hand, a cucumber sprayer made as here directed would give excellent results on potatoes, spraying 6 rows 3 feet apart with 2 nozzles directed on each row. It is most profitable to use the best implements, and the principal reason why sprayers of adequate capacity are scarce is that the public has not yet been educated to demand them.

PREPARATION OF BORDEAUX MIXTURE.

Bordeaux mixture is made from copper sulphate (bluestone) and lime. The copper sulphate is the fungicidal agent and the lime is added to prevent injury to the foliage. It should be made fresh before using each time. The proportions of the ingredients are varied according to the crop sprayed. For young cucumbers the formula advised is as follows:

Copper sulphate	3 pounds
Fresh stone lime	6 pounds
Water	50 gallons

This formula is safe for tender vines in the greenhouse or outdoors and should be used at the start. The excess of lime will tend to prevent accidental injury from errors due to inexperience. A weaker mixture than this is not advisable. Well-established outdoor vines are not injured by a stronger mixture, and it is advised that later in the season 4 pounds of copper sulphate and 4 pounds of lime to 50 gallons of water be used. For potatoes the usual formula is 6 pounds of copper sulphate, 4 pounds of lime, and 50 gallons of water.

It is most convenient in practice to have stock solutions containing 2 pounds per gallon of the respective ingredients. In preparing such solutions, take a 50-gallon barrel and suspend near the top a coarse sack containing 100 pounds of crystallized or granulated commercial copper sulphate. Fill the barrel with water and the whole quantity will be dissolved in a few hours. In another barrel place 100

s of lime freshly slaked. For this purpose choose clean stone
f the best quality. Slake thoroughly by the addition of small
ities of water at a time as needed, stirring until all small lumps
aked. After the slaking is completed keep the paste covered
vater. These stock preparations can be kept for an indefinite
f water is added to replace that lost by evaporation. Both
l be stirred very thoroughly before taking any out. Both the
r sulphate and the lime should be diluted before they are com-
as the physical condition of the mixture varies greatly accord-
the manner of making, and its effectiveness is in a large degree
lent on its physical condition. A poorly made Bordeaux mix-
ettles quickly, is more apt to clog the nozzles, and does not
so well to the foliage.

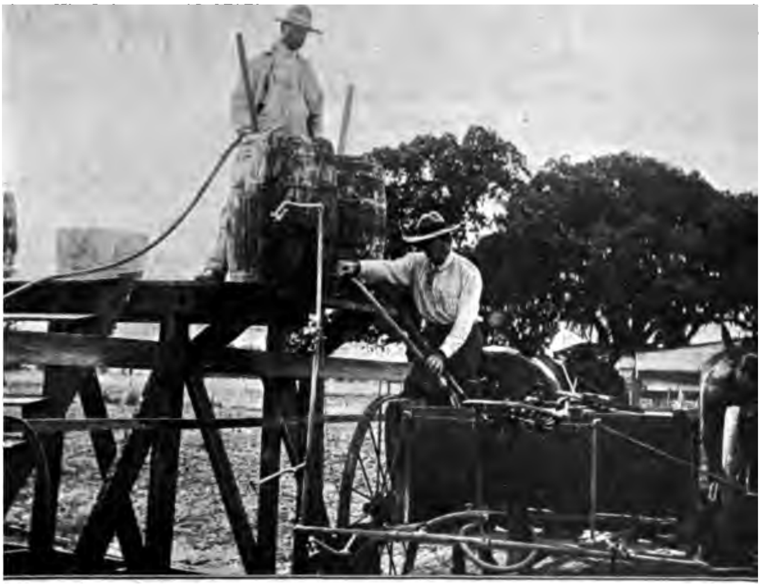

Fig. 8.—Platform for loading machine sprayer.

convenience in making and handling the mixture a platform
nough to permit the spray cart to be driven underneath should
lt. (See fig. 8.) This should be located near the water supply,
sible, so that water can be pumped directly into the barrels on it.
e platform place the stock barrels and two other dilution bar-
A hose or trough should lead from these barrels to the spray

To make 50 gallons of Bordeaux mixture according to the
formula advised on page 20, stir well both stock solutions.
into one dilution barrel 1½ gallons of the copper-sulphate solu-
nd add water to make 25 gallons. Strain into the other dilu-
arrel 3 gallons of the lime milk and add water t

gallons. Then allow both to run together through a strainer int the spray tank. Stir well and apply at once. To make the 4–4–5 formula take 2 gallons of each stock preparation.

COST OF SPRAYING.

The cost of spraying will vary greatly in different sections, according to cost of materials, efficiency of labor, etc. The first cost of a power sprayer similar to that described in this bulletin will be about $150. The cost of applying the mixture can be reduced by thorough organization and the use of labor-saving appliances. Stewart, in experiments on Long Island, found the cost of seven applications by hand to be $9.50 per acre, while Selby, in Ohio, computed the cost of the same number of applications by hand to be $7.70 per acre. In the writer's experience, hand work has been fully as expensive as these figures indicate, but spraying by machinery has been cheaper. The wages of the operator were $2 per day, his helper was paid 75 cents per day, and the teams cost $2.25 per day, a daily total for labor of $5. On the average, 15 acres per day were sprayed, making the labor cost 33 cents per acre. Assuming that 100 gallons per acre were applied, the bill would be:

Copper sulphate, 6 pounds, at 7 cents per pound	$0.42
Lime, 12 pounds, at 1 cent per pound	.12
Total cost of material	.54
Total cost of labor	.33
Cost per acre of each application	.87
Cost per acre of six applications	5.22

There should be added for interest on investment, repairs, and depreciation of outfit, $1 per acre, which increases the total cost to $6.22 per acre.

PROFITS.

Professor Stewart obtained a net profit of $163.50 per acre from spraying cucumbers on Long Island. In the experiments at Charleston, S. C., conducted by the writer in 1905, the crop of about 1 baskets per acre was worth about $115 net, and nearly this entire amount, plus the cost of cultivation, would have been lost had spraying not been attempted on account of the severity of the disease. The cucumber and melon crops as usually grown represent intensive culture and a large money value per acre, which justifies considerable expenditure for protection by spraying. Half-hearted or misdirec efforts will not succeed, but only add to the loss.

SPRAYING, A FORM OF INSURANCE.

hile the diseases described in these pages do not occur every year, rience has shown that they recur frequently, and in years of us epidemics the profits from spraying are so great that the er can afford to spray regularly as an insurance against loss. instance, the profits from the spraying done in 1905 at Charleston pay for repeating the work every year for at least eighteen years.

WHEN TO BEGIN SPRAYING.

order to be absolutely safe, it is best to make the first applica- early, when the vines begin to run, as it is nearly impossible to x downy mildew after it is once established in a field. A grower understands the relation of warm and moist weather to the dis- and will watch carefully for the first appearance can, however, one or two of the earlier applications in dry seasons. The date ie first appearance varies greatly in different seasons and is not a guide.

INTERVAL BETWEEN SPRAYINGS.

iere is also room for some judgment as to the proper interval een sprayings. If the vines are growing very slowly and the her is dry, once in ten days will be sufficient. As the critical time oaches and the blight is actually in neighboring fields, closer ition must be given and the spraying should be repeated weekly. ie vines are growing rapidly, this is not often enough, and it is r to spray twice a week. The aim should be to keep all the leaves ected by a covering of the Bordeaux mixture. There is a tend- to relax vigilance toward the end of the season, but this should be ded. When the disease is in the field and all around, more pro- on should be given the vines.

EFFECT OF BORDEAUX MIXTURE ON THE FRUIT.

ie possibility of objection being made to the stain of the Bordeaux ure on the fruit has been considered. In the case of cucumbers, fruits are so protected by the leaves and develop so rapidly that stain appears, and this is easily rubbed off. Several thousand els were harvested from the fields sprayed in 1904 and 1905 and bjection was made by the purchasers to the slight stain. Such ctions have no valid foundation, for it has been conclusively onstrated that there is no danger of poisoning from eating yed fruits. Even were the skins eaten, which is not true with ns and cucumbers (except in the case of pickles), an enormous quantity would have to be eaten before any appreciable amount of copper could be taken.

CONTROL IN THE GREENHOUSE.

Both downy mildew and anthracnose attack cucumbers grown under glass and sometimes do much injury. It should be less difficult, however, to prevent these diseases in a greenhouse, where the conditions are more fully under control, than in the open field. The houses are sometimes started early in the fall, while outdoor crops in the neighborhood are still affected by disease. There is especial danger in such cases that downy mildew or anthracnose will gain a foothold and persist through the winter, making the greenhouse a center for the infection of near-by fields the next spring. In a locality where these diseases prevail it would be well to burn sulphur in the houses before any plants are put in, bearing in mind that its fumes are very destructive to all vegetation. Give the beds a thorough cleaning, and whitewash all exposed walls and woodwork. The management of the houses is an important factor in controlling these troubles. Lack of ventilation and overwatering favor the spread of disease, but where the requirements of the cucumber crop are fully understood fungi rarely give much trouble. Should any appear, spraying with Bordeaux mixture must be resorted to. The 3-6-50 formula, advised on page 20, should be used, and the mixture should be applied thoroughly. It is important that the lower as well as the upper sides of the leaves be covered. Repeat the applications weekly.

Powdery mildew of the cucumber, a white surface covering of the leaves, is common in some houses. Its presence indicates excessive moisture and lack of ventilation. The best remedy is attention to these points, together with the evaporation of sulphur, best accomplished by making flowers of sulphur into a paste and applying this to the hot-water pipes or evaporating it in a shallow pan placed on a sand bath.

O

Lane Medical Libr

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 232.

OKRA:

S CULTURE AND USES.

BY

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Assistant Horticulturist, Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., September 1, 1905.

Sir: I have the honor to transmit herewith a paper entitled "Okra: Its Culture and Uses," and to recommend its publication as a Farmers' Bulletin. This paper was prepared by Mr. W. R. Beattie, Assistant Horticulturist of this Bureau.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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OKRA: ITS CULTURE AND USES.

INTRODUCTION.

'rom time to time the list of American garden crops has been reased either by the addition of one already in use in the Old rld or by the improvement and domestication of our wild species. the case of okra the former is true, as it has been in use in the diterranean regions for centuries. In the Southern States it has n extensively used for many years, but up to the present time has n cultivated to only a slight extent in the middle and northern tion of this country.

)kra has no great food value, and it is not probable that it will r become a very important crop commercially, but a few plants m a desirable addition to the vegetable garden. It is used prin-ally for flavoring soups and preparations wherein meat forms an portant part, and to these it adds a very pleasant taste and muci-inous consistency. Some persons may not enjoy the flavor of ra at first, but after eating a few times of dishes containing it a te for it is acquired.

BOTANY AND GEOGRAPHY OF THE PLANT.

Okra, or gumbo,[a] as it is commonly called (*Hibiscus esculentus* L.), a tropical annual belonging to the order Malvaceæ. This order ludes some important economic plants, of which cotton and okra ve the greatest commercial value, and such ornamentals as the utilons and many varieties of hibiscus. The okra plant somewhat embles that of the cotton, though having much larger and rougher ves and a thicker stem. Its flowers are similar to those of the ton in size, shape, and color, are always single, and there is very le variation between those of different varieties.

The original home of the okra plant is not definitely known, but it either Africa, the West Indies, or Central America. De Candolle, after a discussion of the matter, concludes that okra must have ha its origin in Africa, since it is mentioned as having been under cult vation by the Egyptians as early as 1216 A. D., long before the dis covery of America. The fact that many tons of okra pods ar annually grown and consumed in Turkey, the northern part o Africa, and the Mediterranean region generally, and that their use in America is limited to recent years, would tend to strengthen the theory of African origin.

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[a] Sometimes spelled "gombo."

Reference to the American seed-trade catalogues will show that okra is entered therein under more than fifty varietal names, the greater number of which are synonymous. The pods have found use throughout the Southern States, especially near New Orleans, where the employment of Creole cooks has created a greater demand. While the commercial value of this crop is at present not great in this country, the demand is constantly increasing. It is the purpose in this bulletin to encourage a more general distribution and use of okra by giving cultural hints, descriptions of a few of the leading varieties, and directions as to some of the methods of preparing the pods for food.

Okra may be grown throughout the greater portion of the United States, but only one crop can be produced during a season in the northern part of the country. In the region around New Orleans successive plantings are made and a constant supply is maintained. The plant is of a tropical nature and will not endure frost, but the pods begin to be produced very soon after the plants start into rapid growth and continue to form for several weeks, especially if all pods are removed while young and no seeds allowed to ripen upon the plants.

THE SOIL AND ITS PREPARATION.

The soil upon which okra can be most successfully grown is a rich mellow loam, plowed rather deeply and well worked over with pulverizing tools. After the seedlings become established and the roots get a firm hold of the soil, the growth is very rapid and a large amount of available plant food, especially of a nitrogenous nature, is required. Quick-acting commercial fertilizers may be applied in moderate quantities, but these should be well mixed with the soil. The same conditions that will produce good cotton or corn will be found suitable for the production of okra.

PLANTING THE SEED.

Throughout the Northern States planting should be done as early as possible in spring, or as soon as the soil is warm enough for the planting of general garden seeds. In the Southern States, where a continuous supply is desired, successive seedings of four or five weeks apart should be made. Plant in rows, 3½ feet apart for the dwarf types and 4½ feet for the larger-growing varieties. Scatter the seeds in drills, or plant loosely in hills, as with corn, and cover to a depth of 1 or 2 inches, according to the compactness and moisture content of the soil. The seeds may be planted with any good seed drill, but when placed in hills they should be separated 3 or 4 inches to allow space for the development of the stems. If the soil is reasonably warm, germination will take place within a few days, but should there be a heavy rainfall in the mean time the soil should be lightly cultivated between the rows and the crust broken over the seed by means of an iron rake.

CULTIVATION.

As soon as the plants are well established they may be thinned to three or four in a hill, or, if grown in drills, to 12 or 14 inches for the dwarf and 18 to 24 inches for the larger growing varieties. Where vacant places occur from failure in germination they may be filled in by transplanting. Cultivate as in the case of corn or cotton, keeping the ground well stirred and the surface soil loose, especially while the plants are small. After the leaves begin to shade the ground, very little cultivation is necessary except to keep the land free from weeds. A poor soil and insufficient moisture will yield pods of inferior size and quality, and irrigation may often be desirable in order to produce a marketable crop.

Okra is sometimes grown as a mixed crop with cotton, the okra being removed before the cotton begins to mature; but this practice is not to be recommended, as both crops draw heavily upon the nitrogenous matter of the soil. The okra plants will usually continue to grow until late in the season, but after a time the pods are not so large or tender as those produced earlier in the season. As the pod is the only part of the plant ordinarily used for food, it is desirable to secure a rapid and continuous growth in order to produce the greatest quantity of marketable pods.

GATHERING AND MARKETING.

As soon as the plants begin to set fruit the pods should be gathered each day, preferably in the evening. The flower opens during the night or early morning and fades after a few hours. The pollen must be transferred during the early morning, and the pod thus formed will usually be ready for gathering during the latter part of the following day, although the time required to produce a marketable pod varies according to the age of the plant and the conditions under which it is grown. The pods should always be gathered, irrespective of size, while they are still soft and before the seeds are half grown

Figure 1 shows a flower, together with the pods formed the two previous mornings, the middle one of which is in the proper condition for gathering. The full-grown pods shown to the right and left of the flower were from those allowed to mature for seed. The pods, after being gathered in large baskets, are sorted and placed upon the market in pint, quart, and half-peck berry boxes. To be in first-class condition the pods should reach the consumer within thirty-six hours after having been gathered, but may be kept for several days in cold storage or by moistening and spreading them thinly upon wood trays in a cool cellar. The pods should never be shipped in tightly closed crates or in great bulk, as they have a tendency to become heated.

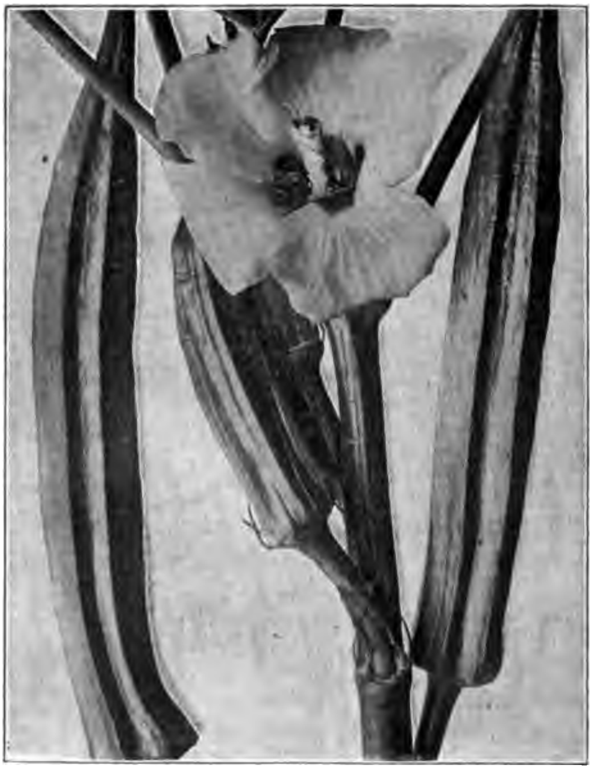


FIG. 1.—Flower and pods. Pod in center in prime condition for gathering; the larger pods have been allowed to mature for seed.

CULTIVATION FOR SEED.

If okra is to be grown for seed alone, only one variety should be planted, or if more than one variety is grown each should be separated from the other by at least one-fourth mile to prevent mixing.

When several varieties of okra are grown near each other no seed should be saved except that produced by the method of bagging and hand pollination. To secure seed in this way is a rather simple matter when only a small quantity is required, as the pods formed on a single day when the plants are at their best will produce enough seed. The bags should be tied over the flower buds in the evening and the pollen transferred early the following day. Replace the bags immediately, as an insect or the wind may at any moment bring to the flower the pollen of another variety. After going over all the flowers of a variety it is well to return to the first three or four and repollinate them in order that they may receive pollen from different individual flowers of the same variety and to insure perfect fertilization. Before beginning upon another variety the brush used for transferring the pollen should be thoroughly cleaned. If a brush is not available, use a portion of a young leaf, folded together between the thumb and finger, to convey the pollen. This improvised brush should be discarded and a new one adopted for each variety. The bags need remain only during the day on which the pollen is transferred and may be replaced by a tag to mark the pod. The seed should remain on the plant until fully ripe.

The common bumblebee is a frequent visitor to the flowers of the okra, and a single bee was on one morning observed to pollinate over 500 flowers, comprising more than 50 separate samples. In this instance practically every flower in the field was visited and pollinated, although no pollen had previously been transferred. This observation demonstrated the necessity of great care to prevent cross-pollination. Our variety tests with okra have shown that seed growers have not always succeeded in keeping the varieties separate, and as a result there has been a gradual blending together of all the sorts. In many of the samples all the sorts usually grown are represented.

INSECT ENEMIES AND THEIR CONTROL.

Thus far no especially injurious insects have been reported for the okra crop. Several species have been observed working on the plants by Dr. F. H. Chittenden, of the Bureau of Entomology, but none is particularly injurious. Among these are leaf hoppers, aphides or plant lice, plant bugs, and some forms of caterpillars. The bollworm and other cotton-feeding insects also affect okra. For information on this subject apply to the Bureau of Entomology.

USES.

The principal use of okra is in soups and various [illegible]tions in which meats, form an important [illegible] gumbo soups, to which the young pods impart an excellent fl besides giving a pleasant laginous consistency. The y seeds are occasionally cook the same way as green peas the very young and tender are boiled and served as a with French dressing. Bot the stem and the mature pod tain a fiber which is employ the manufacture of paper.

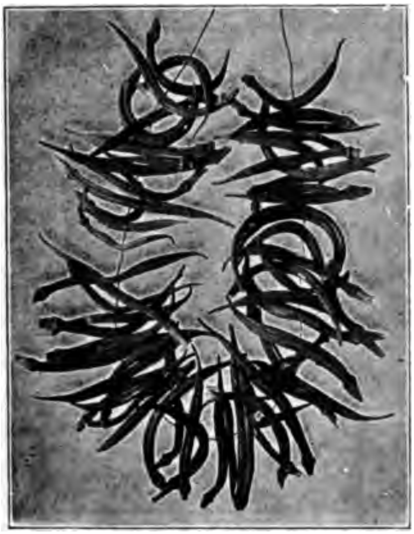


FIG. 2.—Large pods dried for winter use.

In countries where large tities of the pods are cons they are dried and preserv be used during the part o year when a fresh supply ca be obtained. There are se methods of drying the pods. one of these the pods are cut slices crosswise and about half inch thick; the slices are then spread upon muslin-co frames and dried, after which the okra is stored in thin bags until required for use. By another and a more common method, the very young pods are strung upon coarse threads and hung up to dry (fig. 2). In Turkey alone there are tons of the pods preserved in this manner each year. A variety much used for drying is that known as *petite gumbo*, or small okra. The pods of this variety are selected when only about one-half inch in length and of uniform size. These are strung on a string of coarse fiber and hung up to dry (fig. 3).

No copper, brass, or iron cooking vessels should be employed in preparing okra, as the metal will be absorbed and the pods discolored or even rendered poisonous. The cooking should be done in agate, porcelain, or earthen ware.

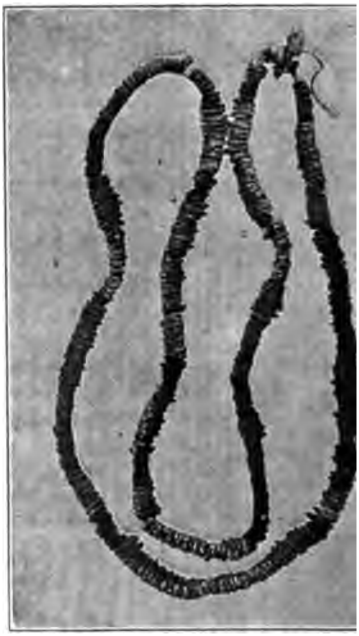


FIG. 3.—Small pods dried for winte

METHODS OF PREPARING.

following are recipes for a few of the preparations of which rms a part. With two exceptions, they are all taken from the ıe's (New Orleans) Creole Cookbook.

OKRA SOUP.

ıds of beef, without fat or bone;
of okra, chopped fine;
urth pound of butter;
ts of cold water;
n, sliced and chopped;
nd pepper.

e beef into small pieces and season well with pepper and salt. Fry it in kettle with the onion and butter until very brown. Then add the cold ıd let it simmer for an hour and a half. Add the okra, and let it simmer ɔr three or four hours longer.

WINTER OKRA SOUP.

of good New Orleans okra;
of tomatoes;
ns, chopped fine;
espoonfuls of butter;
n oysters;
espoonfuls of rice;
pepper pod, without the seeds.

the onions and fry them in the butter. Wash the rice well, then onions, tomatoes, and pepper together in about three quarts of water pint of oyster water, for about three hours, stirring frequently. Ten before serving add the okra and let it come to a boil. Then drop in the boil up once, and serve.

OKRA GUMBO.

ken;
n;
ılf pod of red pepper, without the seeds;
of okra, or about 50 pods;
e slices of ham;
leaf;
of thyme or parsley;
espoonful each of lard and butter;
nd cayenne to taste.

and cut up the chicken. Cut the ham into small squares or dice and onion, parsley, and thyme. Skin the tomatoes and chop fine, saving e. Wash and stem the okras and slice into thin layers of one-half inch ut the lard and butter into the soup kettle and when hot add the chicken ham. Cover closely and let it simmer for about ten minutes. Then add pped onions, parsley, thyme, and tomatoes, stirring frequently to prevent g. Then add the okras, and when well browned add the juice of the s, which imparts a superior flavor. The okra is [illegible] and is scorch if not stirred frequently. For this [illegible] fry the okras separately in a frying pan, seasoning with the pepper, cayenne, and salt, and then add them to the chicken. Equally good results may be obtained with less trouble by simply adding the okra to the frying chicken and watching constantly to prevent scorching. The least taste of a "scorch" spoils the flavor of the gumbo. When well fried and browned, add about 3 quarts of boiling water and set on the back of the stove to simmer for about an hour longer. Serve hot with nicely boiled rice. Round steak may be substituted for chicken, but it must be borne in mind that the chicken gumbo is the best flavored.

Another recipe for okra gumbo which is very similar to the one just preceding, the manipulation being practically the same, is as follows:

1 quart of tomatoes, sliced;
2 pounds of good beef, cut in small pieces;
2 quarts of okras, sliced;
4 tablespoonfuls of butter;
One-half pound of corned ham or pork, cut up;
Small piece of red pepper, without the seeds;
Spray of parsley.

OKRA SALAD.

Boil the young okra pods whole. When cold, dress with vinegar, salt, and pepper, or, if preferred, use plain French dressing and serve very cold. This is a most delightful summer salad, the okra being very cooling.

BOILED OKRA.

1 quart of young okra;
1 tablespoonful of vinegar;
Salt and pepper to taste.

Wash the okra well in cold water and place in a porcelain or agate saucepan. Add a pint of water and a teaspoonful of salt. Cover the saucepan and let the okra simmer for about half an hour. Place in a dish, season with salt and pepper, pour over the okra a tablespoonful of tarragon vinegar, and set to cool. Serve as a salad with roast meats, etc.

BAKED GUMBO.

Place a thin layer of rice in a baking dish, add a layer of sliced okra, then a layer of sliced tomatoes; add salt, pepper, a little currie, and a small lump of butter. Repeat with alternate layers of rice, okra, and tomatoes until the dish is filled. Cover and bake in the oven until the rice is thoroughly cooked. Remove cover and brown on top. Serve in the baking dish. The rice should be washed in cold water before using, and the okra pods and tomatoes washed and sliced rather thinly.

VARIETIES.

There are three general types of okra, viz, tall green, dwarf green, and lady finger.

Each of these is again divided according to the length and color of the pods, making in all six classes or varieties, namely, tall green, od; tall green, short pod; dwarf green, long pod; dwarf green, pod; lady finger, white and lady finger, green pod. ariations from these are the results of mixtures, e crosses or hybrids being d. These mixtures are separated and referred to rent type, and a little at- n to roguing and selec- is necessary in order to the varieties pure. It is ial that the varietal strain l be pure in order that a m and marketable lot of nay be produced.

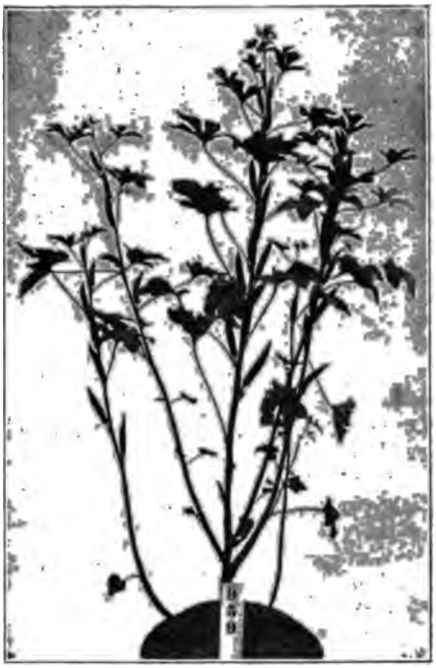
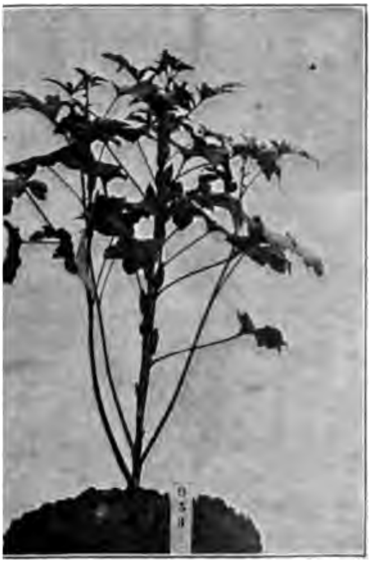


FIG. 4. - Tall green, long-pod type.

CRIPTION OF TYPES.

green.—Height of plant, feet; habit of growth, up- not spreading, sometimes ing near the ground, but ms erect; leaves large, borne on long petioles; pods in axils of leaves, on short stem; color of pods, green.



G. 5.—Tall green, short-pod type.

Tall green, long pod.—Pods long, 3 to 5 inches when ready for marketing, 7 to 11 inches when mature; five-eighths to 1¼ inches in diameter; 5 to 8 sided. (Fig. 4.)

Tall green, short pod.—Pods short, 1½ to 2 inches when ready for marketing, 3 to 5 inches when mature; 1 to 2 inches in diameter; 7 to 11 sided. (Fig. 5.)

Dwarf green.—Height of plant, 20 inches to 3½ feet; habit of growth, bushy, spreading from near the ground; leaves rather small, on slender petioles; pods green.

arf green, long pod.—Pods long, 2 to 4 [illegible] for marketing, 6 to 10 inches when mature; five-eighths to 1¼ inches in diameter; 5 to 8 sided, tapering to point at blossom end, point usually curved inward toward the stem of the plant; leaves deeply cleft or divided. (Fig. 6.)

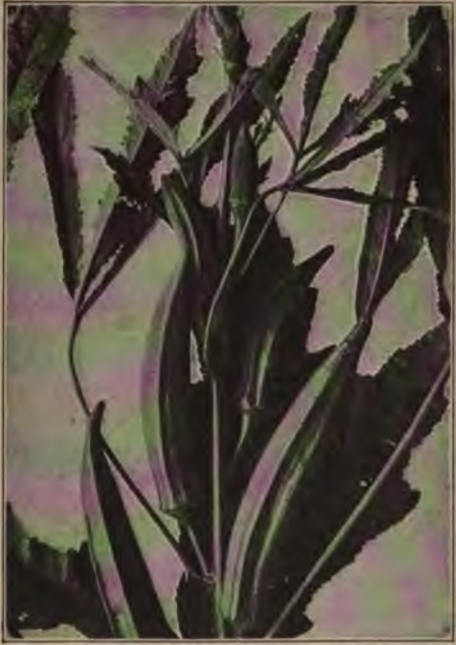


FIG. 6.—Dwarf green, long-pod type.

Dwarf green, short pod.—Pods short, 1½ to 3 inches when ready for marketing, 3 to 6 inches when mature; 1¼ to 2½ inches in diameter when fully grown; 7 to 12 sided; leaves large, almost entire. (Fig. 7.)

Lady finger.—Height of plant, about 3 feet, very much branched and of bushy habit; leaves large, borne on long petioles, the lower ones sometimes more than 2 feet in length. The entire plant is of a lighter color than either of the other types. The only distinction between the varieties of this type is found in the color of the pods. Pods 4 to 5 inches long when ready for gathering, 6 to 10 inches when mature; three-fourths to 1¼ inches in diameter when mature; slightly 7 to 8 angled; and covered with numerous soft hairs. (Fig. 8.)

Lady finger, white pod.—Pods greenish white or nearly white.

Lady finger, green pod.—Pods pale green, in some cases nearly pure green.

IMPORTED VARIETIES.

The following varieties of okra have been imported by the Department of Agriculture.

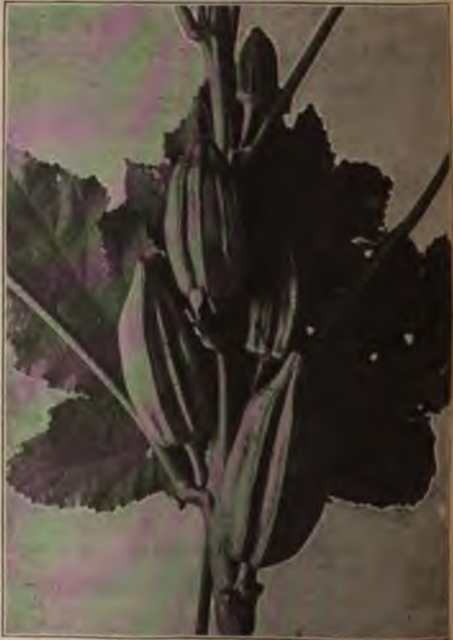


FIG. 7.—Dwarf green, short-pod type.

e serial numbers are taken from the various inventories of the partment.

1. From Algeria. Received through Mr. W. T. Swingle, 1899. Donated by Doctor Trabut, government botanist of Algeria.

The above-named importation is known as "White Louisiana." ther dwarf; 2 to 2½ feet high; spreading. Pods 8 to 10 inches g when fully grown, slightly curved and tapering at the point; face of pods almost smooth, slightly 7 or 8 angled, pale green or ıost white. This variety yielded better than any other. The pods tender and keep re- rkably well. Lady ger, white-pod type g. 8).

5. From Smyrna. Received through Mr. W. T. Swingle, 1899. Seeds purchased from a Greek gardener.

This variety is a d grower, reaching height of about 4 t. The leaves are rage size. Pods g and slender, be- 8 or 10 inches in gth and only three-fourths in diameter; very tender; free m strings; and of a light-green color. It is very productive and pods in a comparatively short time after planting. Tall green, g-pod type.

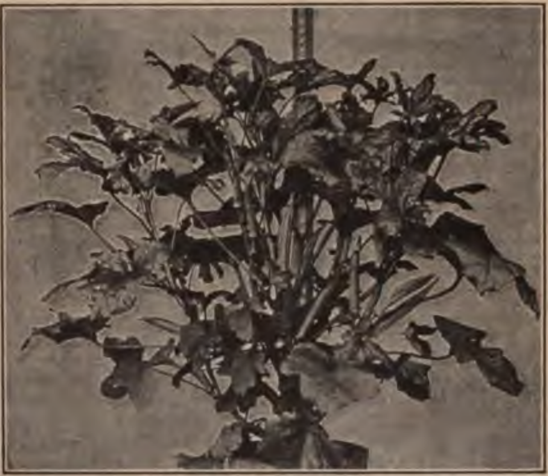


FIG. 8.—Lady-finger type.

From Kasaba, near Smyrna. Received through Mr. W. T. Swingle, 1899. "*Sultanie.*"

he "Sultanie" variety grows to a height of about 4 feet, with der stems. The leaves are average size, rich in color, and abun- t. The pods are 3 to 6 inches long, three-fourths inch in diameter, 8-sided. A moderate producer, and the pods are not so tender me others. Tall green, short-pod type.

From Aldin. Received through Mr. W. T. Swingle, 1899. This is a dwarf variety, growing only about 20 inches in height.

he pods are 3 to 5 inches in length when mature, blunt at point, 10 sided, and must be gathered while quite small, as they soon me tough and stringy. While this variety produces only a mod- e crop and continues but a short time, it is worthy of cultivation its earliness and may be discarded after the other varieties come into bearing. Dwarf green, short-pod type, of which it is an early selection.

3906. From Venice, Italy. Received through Messrs. Lathrop and Fairchild, 1899. Grown from seed imported from Constantinople into Venice from the monastery of San Lazare.

This variety grows about 4½ feet high; stems slender. The pods are 6 to 10 inches long and five-eighths inch in diameter, 7 or 8 sided, very tender, and keep well. This is a late variety, very productive, has a well-formed pod, and is one of the most desirable sorts. Tall green, long-pod type.

3979. From Cairo, Egypt. Received through Messrs. Lathrop and Fairchild, 1899. A long-fruited native Egyptian variety.

This is a strong grower of the dwarf class. Its leaves are large and borne on long petioles. Pods 6 to 10 inches long when mature, 4 to 5 inches when ready for marketing; 7 or 8 angled, and covered with numerous soft hairs; produces well, and the pods remain tender for a long time after gathering. A splendid new variety. Lady finger, green-pod type.

3980. From Cairo, Egypt. Received through Messrs. Lathrop and Fairchild, 1899. Short-fruited variety.

This variety is rather stocky and a good grower, 3 to 4 feet high, with very thick stems. Leaves large, on rather long heavy petioles; pods 4 to 5 inches long and 1½ inches in diameter, 7 to 11 sided, and free from prickles. This is a splendid variety, but the pods become tough and stringy if allowed to remain too long upon the plant. The pods will keep a long time, however, if removed while tender. Tall green, short-pod type.

SUMMARY.

Okra may be considered a desirable addition to the farmer's garden, and it can be grown in almost any locality.

Okra can be produced on any good soil, and the crop requires no special attention other than that which would ordinarily be given a crop of corn or cotton.

Plant early in the spring, or as soon as all danger of frost has passed; keep the pods well picked, in order that the plants may not become exhausted by the maturing of the seed, and the pods will continue to be produced until late in the fall.

Do not cook the pods in plain iron cooking utensils or in copper or brass.

Remember that the taste for the okra flavor has to be acquired by some persons.

The varieties of okra best adapted to general use are the dwarf green, long-pod (fig. 6), and the lady-finger ("White Louisiana") types (fig. 8).

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 233.

Experiment Station Work,

XXXI.

Compiled from the Publications of the Agricultural Experiment Stations.

ROOT SYSTEMS OF PLANTS.
FERTILIZERS FOR ASPARAGUS.
MUSHROOM CULTURE.
ONIONS IN THE SOUTHWEST.
ETHER FORCING OF RHUBARB.
NOODLES.
CONDIMENTAL FEEDS.
BEEF *VS.* DAIRY TYPE FOR BEEF PRODUCTION.
FEEDING SKIM-MILK CALVES.
ANIMAL FOOD FOR DUCKS.
MILK FROM DISEASED COWS.
CIDER VINEGAR.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

THE AGRICULTURAL EXPERIMENT STATIONS.

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- Canebrake Station: *Uniontown;* J. M. Richeson.[b]
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[a] Director.
[b] Assistant director.
[c] Special agent in charge.
[d] Acting director.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

THE ROOT SYSTEMS OF FIELD CROPS.[b]

The root systems of our cultivated plants bear a most important relation to the cultivation of the crops, the application of fertilizers, and the moisture content of the soil; and in order to understand fully the reasons for the different cultural practices it is really necessary to know to what extent and in what way the roots of the various crops develop. That the development of the root systems of our common cereal and forage crops is not so well understood as might be supposed is demonstrated by the fact that samples of plants prepared with a view to showing the lateral as well as the downward extension of the entire root system in its natural position always arouse great interest in observers of all classes, and even cause surprise to persons who have spent their whole lives upon the farm, and in many cases growing these very crops year after year. Such samples were exhibited at the World's Fair in Chicago in 1893, in Paris in 1900, and in St. Louis in 1904, and in every instance they proved to be most instructive object lessons.

The natural distribution of the roots of most of our common field crops has been studied among others by the Wisconsin, North Dakota, Kansas, and Minnesota experiment stations, and these institutions also prepared the samples which attracted so much attention at the different expositions. The bulletins on the results of these investigations, published from time to time, are here summarized for the purpose of collecting the data with reference to all the crops under experiment.

In studying the natural distribution of the roots of different field crops the plants are grown in the field in the ordinary way. At the time the root samples are to be prepared a trench 2 feet wide and several feet deep is dug about the block of earth containing them. A wooden or iron frame is closely fitted over this block of earth and the sides of the same are covered with common wire poultry netting. When this cage is properly fitted the top part of the frame rests firmly on the surface of the ground about the base of the plants, and plaster of Paris, reduced to a thin paste with water, is then poured into it and allowed to set and harden. Small rods made from No. 10 or No. 12 galvanized-iron wire, straightened and cut into pieces about 2 inches longer than the width of the cage and sharpened at one end, are then run through the block of earth one way, or both ways when the cage is square, and secured by looping the blunt end around the wire netting. The arrangement of the rods is such that when the earth is removed the roots and root fibers are held in practically the same positions they occupy in the soil at the time of growth.

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[a] A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

[b] Compiled from Wisconsin Sta. Rpts. 1892, p. 112; 1893, p. 160. New York State Sta. Rpt. 1888, p. 171. North Dakota Sta. Buls. 36, 43, 64. Kansas Sta. Bul. 127. Colorado Sta. Rpt. 1896, p. 181. Minnesota Sta. Bul. 5.

After the rods are fixed the earth is slowly and carefully washed away by applying water through a small force or spray pump and the roots left suspended on the wire rods. The hardened plaster of Paris represents the surface of the ground and supports the upper parts of the plant. This method requires no artificial preparation of the soil before planting the crop, and the samples secured show the actual development and distribution of the roots under natural field conditions.

Corn root system.—At the Wisconsin Station samples of corn taken 42 days after planting, when the tops were about 18 inches high, showed that the roots of 2 hills met and passed each other in the center of rows 3½ feet apart, and had penetrated the soil to a depth of about 18 inches. The surface roots sloped gently downward toward the center of the row, where they were about 8 inches below the surface. At the time of the last cultivation, when the corn was nearly 3 feet high, the roots were found to occupy the entire soil down to a depth of about 2 feet, and the surface laterals descended in a gentle curve toward the center of the row and passed one another at a depth of only 6 inches. A third sample taken when the corn was coming into full tassel showed that the roots had fully occupied the upper 3 feet of soil in the entire field and that the surface laterals at this time had risen still higher, a few of them being scarcely 5 inches beneath the surface. At maturity the roots extended fully 4 feet into the soil and the upper laterals were within 4 inches of the top of the ground.

In studying the total root distribution of corn from 9 to 27 days old it was found that at the end of 9 days some of the roots had extended laterally to a distance of 16 inches, and that some had reached a depth of 8 inches. The tips of the longest roots were 6 inches below the surface and no roots were nearer the surface than 3 inches at 6 inches from the hill. Eighteen days after planting the tips of the longest roots had spread laterally to a distance of 18 inches and were 5 or more nches below the surface, while the longest roots extending downward d scarcely reached 12 inches, and at 6 inches from the hill no roots were nearer the surface than 2 inches. Twenty-seven days after planting the greatest depth reached by the roots was 18 inches, and the greatest lateral extension 24 inches from the hill, with the tips 4 inches below the surface. The depth of the roots at 6 inches from the hill was the same as 9 days before.

In similar work along this line the North Dakota Station found that 30 days from planting the main roots appeared to have developed laterally and but few had penetrated to a depth of 12 inches, the bulk of the roots lying within 8 inches of the surface of the soil. An examination 55 days from planting, when the plants were 54 inches high, showed that the primary roots had penetrated to a depth of 2½ feet and that many of the horizontal roots now extended from hill to hill. The lateral roots frequently sent up feeders within 2 inches of the surface. A third sample was taken 90 days from planting and soon after the corn had been killed by frost. The roots at this time seemed to be still alive and growing. At this stage the roots had penetrated the ground to a depth of 3½ feet and they fully occupied the soil of the entire field. (See fig. 1.)

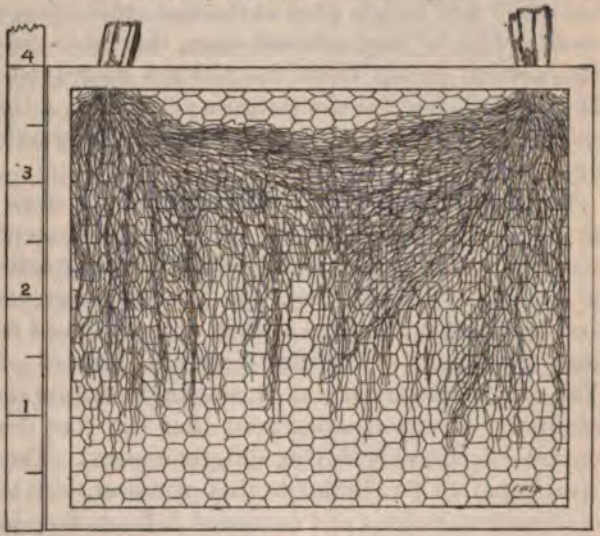

FIG. 1.—Root system of corn.

Very similar results are reported from the Colorado Station with corn grown on a mulatto sand. On a black adobe soil the roots grew mostly in the upper foot of soil, while in another heavy soil containing much clay they fed usually in its upper 2 feet of soil. Investigations in a rich sandy soil at the Minnesota Station show that in spring, when the surface soil is comparatively warm, the roots start out nearly horizontally, spreading 2 to 5 feet from the stalk. As the upper soil becomes dry they turn downward, attaining a length of 3 to 8 feet. The later roots grow more vertically downward from the time they start growth. The New York State Station found that in deeply prepared soil corn roots penetrate deeper than in shallow soil.

The Kansas Station found that the roots of corn are more extensive than those of Kafir corn and sorghum. Kafir corn showed a thick growth of surface roots, while the root system of sorghum had a greater resemblance to that of corn. The roots of listed corn had developed at a uniform depth and the surface roots were uniformly deeper in the soil than in level-planted corn. It was also shown in these experiments that the roots of corn and other cultivated crops spread out farther, but did not grow so deep into the soil as the roots of wheat, oats, and barley.

All these experiments indicate that, by cultivating deeply, the large lateral roots of corn lying at a depth of 4 inches midway between the rows are likely to be broken. It is believed that as roots of listed corn lie deeper, corn planted by this method may be cultivated close to the hill and 3 to 4 inches deep at the last cultivation without injury to the roots, while in level-planted corn, the roots rising nearly to the surface several inches from the hill are destroyed by close cultivation. Deep cultivation for the purpose of forming a thick soil mulch is considered necessary, however, for the last cultivation of corn in hot and dry climates.

Small grains.—Wheat roots examined 110 days after sowing the seed at the North Dakota Station were found to extend directly downward, sending out numerous small feeders which practically occupied the soil to a depth of about 4 feet. In later experiments the roots of durum and bread wheat reached a depth of more than 4 feet, and again showed that the system of rooting is vertical instead of lateral, as in corn. The root development was greater in the durum than in the bread wheat samples. It was also observed that the root development in cereals varied considerably during different years. The root system of oats was found to be similar to that of wheat, but the roots were longer and more numerous and extended fully as deep into the ground. The roots of emmer resembled those of wheat and extended to about the same depth. A sample of winter rye taken July 7 showed that the roots had reached a depth of only 3 feet, and that their development was smaller than in other samples of cereals generally. It is believed that early in the season the soil in the latitude of the station is too cold below a depth of 3 feet to admit of root growth. At the Kansas Station oats and barley produced a large fibrous growth of roots in the surface soil, but this was not equal to the growth of fibrous roots in the upper soil made by some of the perennial grasses.

Flax root system.—The North Dakota Station found the root system of flax quite unlike that of the other plants studied. It consisted of a single small thread-like tap root running vertically downward and giving off small short side roots in the first 12 to 18 inches. The tap root reached a depth of 3 to 4 feet. Unlike the roots of the other plants, the flax roots did not form a network near the surface of the soil, nor did they occupy it so completely.

ystems of grasses.—The North Dakota Station also examined
s of 1 and 2 year old plants of *Bromus inermis* and found that
· old the roots had attained a depth of over 4 feet and formed
od, while the roots of the 2-year-old grass had reached a depth
st 5½ feet. In comparing the root systems of native prairie
timothy roots, and the roots of *Bromus inermis*, it was found
roots of the native prairie grasses did not make as heavy a
he cultivated ones, and that the
amined reached less than 3 feet in
In later work a brome grass
n taken from a 3-year-old sod
the densest rooting of all samples of
nd forage crops. Native slender
rass, also from a 3-year-old sod,
ave the strong root growth of the
rass although its root system was
han that of any other crop studied.
nsas Station also found that the
growth of fibrous roots in the sur-
was made by the perennial grasses
ared with cereal and other crops,
certain species also extended their
eper into the soil than any other
crops except perennial leguminous

ystems of legumes.—At the Kansas
alfalfa was the deepest-rooted crop
The plant developed only a small
of fibrous roots near the surface,
ipal root development being deeper
il. (See fig. 2.) Cowpeas and soy
peared to be light-rooting crops.
orth Dakota Station the roots of red
uring two years of development
wn over 4 feet and quite fully occupied the upper 3 feet of
imson clover roots in a single season attained a depth of 3
ugust 22.

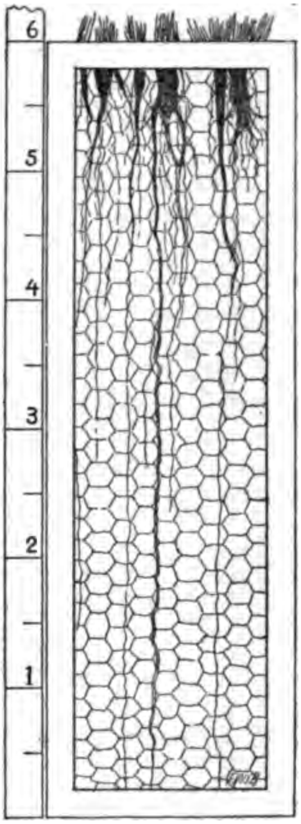

FIG. 2.—Root system of alfalfa.

root system.—Samples of an early and late variety of potatoes
orth Dakota Station showed that the main portion of the root
of this plant is shallow. Forty-three days after planting the
part of the root development was found to lie within 8 inches
urface of the ground. The lateral roots had extended from
ll and interlaced. Some of the princip [illegible]

[illegible] to be only [illegible] inches from the surface at 6 inches from the hill. This root development indicates the necessity of shallow cultivation of the crop, and this was confirmed in experiments with deep and shallow cultivation, the results showing a decided advantage for the shallow cultivation of potatoes [illegible]. It was also shown that late potatoes [illegible] more freely and more deeply than early ones, and as a result will not [illegible] as close planting as the early varieties. When the hills are [illegible] feet apart each way the soil is very fully occupied by the roots to a depth of [illegible] feet.

Sugar-beet root system.—Sugar-beet plants examined by the North Dakota Station at maturity, or 133 days after planting the seed, presented a deep root extending almost perpendicularly downward into the ground, the lower part being quite small and thread-like and reaching to a depth of more than 3 feet, and the lateral roots starting 4 or 5 inches from the surface with but little root development in the upper 6 inches of the soil. The greatest amount of branching and fibrous growth of beet roots took place in the space between 8 and 14 inches in depth. (See fig. 3.) The effect of subsoiling on the root growth and development of sugar beets, as studied by this station, resulted in a considerably better development of feeding roots and a more symmetrical development of the main root on the subsoiled plats. The Kansas Station also found that the root system of the sugar beet lies comparatively deep, and that the crop therefore admits of deep cultivation.

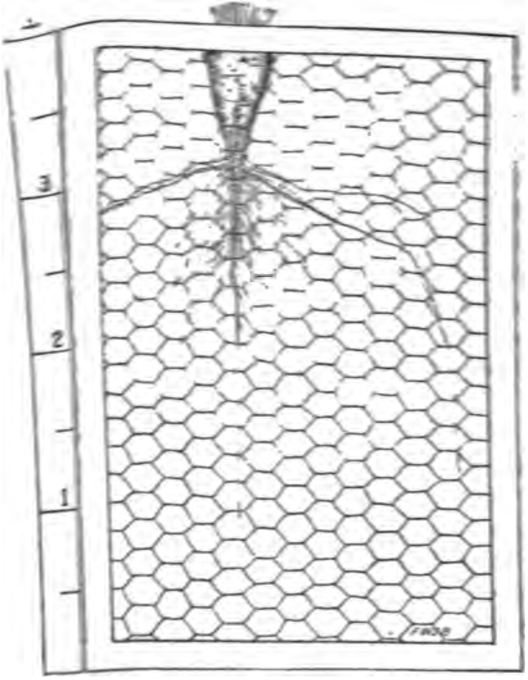

FIG. 3.—Root system of sugar beets.

This study of the roots of plants gives us a clearer idea of the proper methods of preparing and cultivating the soil for the different field crops. In general, root systems of crops like corn, potatoes, beets, beans, etc., reach from row to row and near the surface and hence should be given shallow cultivation, though beets may be cultivated deeper than the other crops mentioned. The roots of cereals, grasses, clovers, and alfalfa grow more directly downward and generally reach deeper into the soil than the cultivated crops.

FERTILIZERS FOR ASPARAGUS.[a]

Salt was long considered an essential fertilizer for asparagus. The natural habitat of asparagus is the seashore, and it was reasoned, therefore, that salt was beneficial to this crop. In modern commercial practices, however, beds of asparagus have been found to yield as well without salt as with it, and this has raised the question whether the use of salt is to be considered essential in the culture of asparagus.

E. Walker, of the Arkansas Station, has recently made an experiment to determine the value of salt in asparagus culture. One-half of a bed containing one-seventh of an acre was fertilized with salt at the rate of 1,000 pounds per acre. The asparagus field was in its second year at the time the experiment was started. As far as could be seen there was no appreciable effect of the salt upon the growth of the asparagus nor in preventing the growth of weeds. The following spring that portion of the field which had received salt the preceding summer was again salted, and this time at the rate of 2 pounds per square yard. The salt was applied in two equal portions at intervals of 20 days. With each variety of asparagus larger stalks and an increased yield was secured where the salt was applied, the average increase being 13.5 per cent in favor of the salted area. Not only was the growth of the stalks increased in the spring, but there was also an increased vigor manifested in the plants throughout the summer and a notably increased glaucous appearance in the salted plants. The salt was entirely effective in preventing the growth of weeds. On the salted area without any hoeing but few weeds appeared, and those late in the season. This beneficial action was believed to have been beyond what might have been assigned to the salt in simply preventing weed growth. The results indicate that while in the field culture of asparagus salt may not be especially useful, in the small garden patch, where intensive culture is practiced and where large amounts of stable manure are applied each year, it may answer a very useful purpose, especially in keeping down weeds.

There has been some question as to whether or not early spring applications of fertilizers will affect the yield of merchantable shoots the same season. As is well known, the food supply of the first shoots to appear in spring is largely derived from food stored in the roots the preceding season. C. P. Close, of the Delaware Experiment Station, reports the results of an experiment in which the value of spring applications of nitrate of soda were studied. In the experiment a half acre of asparagus was fertilized with 100 pounds of nitrate of soda, which was applied in four equal portions at intervals of about 10 days. The first application was made about 10 days or 2 weeks before the cutting season began. Another half acre was left unfertilized for comparison. The yield of stalks from the fertilized plat was 460 pounds and from the unfertilized plat 448 pounds, a difference of only 12 pounds in favor of the fertilized plat. This slight difference might or might not have been due to the use of the fertilizer, but "even admitting that the gain of 12 pounds is due to the 100 pounds of nitrate of soda used, it is not enough gain to justify the use of the fertilizer." The station concludes that "the use of nitrate of soda on asparagus beds during the cutting season can not be recommended." On limed soil at the Rhode Island Station nitrate of soda has proved nearly twice as valuable a fertilizer for this crop as sulphate of ammonia.

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[a] Compiled from Arkansas Sta. Bul. 86; Delaware Sta-
Sta. Bul. 173, Rpt 1904, p. 316; Rhode Island Sta. E

A. T. Jordan reports fertilizer experiments with asparagus which have been under way at the New Jersey Experiment Stations for seven years. The asparagus field is situated on a gravelly clay loam. Plat 1 is fertilized with 20 tons of manure per acre, applied at setting and thereafter in fall or early winter. Plat 2 is given a complete fertilizer consisting of a mixture of the best forms of fertilizing constituents, analyzing 4.5 per cent nitrogen, 7.7 per cent available phosphoric acid, and 13.3 per cent potash, applied at the rate of 500 pounds per acre in the spring. Plat 3 is fertilized with the same fertilizer and in the same way as plat 2, and is given in addition a mixture of equal parts of ground bone and muriate of potash, applied at the rate of 300 pounds per acre in the fall. Plat 4 is fertilized with the same mixtures and in the same way as plat 3, and in addition is given 200 pounds of nitrate of soda per acre about July, or at the end of the cutting season. The average yields obtained from the plats differently fertilized and the cost of fertilizing each plat is shown in the table on page 13. Like data are also shown for the crop of 1903, which is taken as representing more nearly the results in a mature field.

Yields of asparagus with different fertilizers.

lat and kind of fertilizer.	Average first 6 crops.				Crop of 1903.		
	Average annual cost of fertilizer.	Total yield.	Value at 11.2 cents per pound.	Value less cost of manure or fertilizer.	Total yield.	Value at 13.1 cents per pound.	Value less average cost of manure or fertilizer.
		Pounds.			*Pounds.*		
1, manure	$45.38	2,941.7	$329.47	$284.09	5,231.3	$685.30	$639.92
2, complete fertilizer	12.93	3,000.2	336.02	323.09	4,807.9	629.83	616.90
3, complete fertilizer+ ne and potash	18.92	2,605.4	291.80	272.88	4,060.6	531.94	513.02
4, complete fertilizer+ ne, potash, and nitrate of da	24.91	2,384.9	267.11	242.20	3,974.9	520.71	495.80

The table shows that the largest total average yield has been tained from plat 2. The cost of the fertilizer for this plat has also en less than for any other plat and a little more than a fourth as ch as for the plat fertilized with manure. The addition of bone and ash or of bone, potash, and nitrate of soda to the complete ferti- er, as in plats 3 and 4, increased the cost of the fertilizer per acre hout giving any increase but rather a decrease in yield. Consid- ng the 1903 crop alone, the largest yields and greatest net financial urns were obtained from the plat fertilized with manure. The fol- ving year also the largest yields were obtained on the plat fertilized h manure.

Summarizing briefly, the investigations at the various stations indi- e that salt may be used with benefit in the small asparagus bed of e garden and that early spring applications of nitrate of soda are t likely to be of benefit in securing an increased cut of stalks the ne season. As regards commercial fertilizers and barnyard manure asparagus, if the land is in good condition a well-balanced com- ercial fertilizer may produce as good yields as manure and may be eaper.[a]

GROWING MUSHROOMS FOR HOME USE.[b]

Edible wild mushrooms may be found in abundance in pastures and ods throughout the growing season, but especially during the tumn months. Attention has been called to these wild forms by a mber of the experiment stations, and many well-illustrated bulletins ve been published on the subject. Many people are deterred, how- er, from the use of this desirable edible[c] because of a fear of acci- ntally gathering the poisonous kind.

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[a] For a complete account of asparagus culture, see U. S. Dept. Agr., Farmers' Bul. 61.

[b] Compiled from New York Cornell Sta. Bul. 227.

[c] For an account of the food value of mushrooms, see U. S. Dept. Agr., Farmers l. 79, p. 18.

The cultivated mushrooms are not grown as yet to any great exte in the United States. They may be had in cities and in limited qua tities in some of the larger towns, but are usually scarce and expensiv Many people who would enjoy having mushrooms added to the hon menu are debarred because of the difficulty of obtaining them excej at considerable expense and because of unfamiliarity as to methods (home culture.

Owing to the increased interest in mushrooms G. F. Atkinson an R. Shore, of the New York Cornell Station, made a study of metho of mushroom culture on a small scale and have recently reported th results of this work in bulletin form. The main purpose of the wor was to find out by actual trial what success might be expected by th beginner in growing mushrooms where no special houses and no ela orate preparations were made for their culture. Based on this wor the following cultural directions are given:

> Cellars or basement rooms where the temperature in the winter does not go belo 55° or does not rise above 65° are suitable places for growing mushrooms. It is n advisable to make them under the living part of the house, since the odor of th manure will fill the house. They can also be grown in stables which are not too col in the winter. * * * Beds can be prepared on the cellar or basement floor b using the wall for one side of the bed. A board or plank 1 foot to 15 inches in widt can then be stood on edge 3 to 4 feet from the basement wall and held in position b the necessary upright scantlings and supported at intervals to hold the material i position. In this way a box of the desired width and length can be made, the floo of the basement or cellar serving as the bottom. If more space is desired, tiers (beds can be made; that is, 2 or 3 or 4 beds one above the other against the cella wall. This is a common practice. Crosspieces from the uprights can be nailed on upon which the floor of the upper beds can be laid. These should be made of lum ber at least 1 inch in thickness. A space of about 20 to 24 inches should be lel between the top of one bed and the bottom of the one directly above it. All thes places should have some ventilation, but there should not be air currents, and car should be taken to make the rooms in which the mushrooms are planted clean an sweet in order to avoid as far as possible any conditions which would encourag insects and other enemies of mushrooms.

Soil for mushrooms.—The best soil for mushrooms is that made fror horse manure from well-bedded stables. While some straw is desira ble, any large percentage is objectionable and should be removed The manure is cured by putting it under cover in piles 3 to 4 feet dee and of any length and width. These piles soon begin to ferment an heat.

> To prevent its becoming too hot, the manure must be forked over and made int a new pile. This is done by beginning at one end, turning the manure over, shakin it slightly as it is turned into the new pile. It may feel to the hand quite hot, bu as long as it does not turn white or get too dry the heating will not harm it Usually after the manure is well heated, turning once in 2 or 3 days will answer, bu sometimes it is necessary to turn every day.

If the manure becomes too dry, sufficient water may be sprinkled on to make it moist but not wet. It usually requires 10 to 15 or 18 ys to cure, but should not be put in the beds or boxes until the temrature has gone down to 100° F.

Preparation of the bed.—In the preparation of the bed a layer of the arse, more strawy portion of the manure is first put on the bottom nd then thoroughly tramped or pounded down. Succeeding layers re then put on and each packed down until the bed is 10 to 12 or 14 nches thick. For a few days after the bed is made, the temperature s likely to increase, after which it will gradually cool off. A thernometer should be kept in the bed several inches below the surface, nd when the temperature falls to 70° or 75° F. the mushroom spawn nay be planted. Sometimes 1 part of rich soil is used with 4 or 5 arts of manure in making up the beds. In such cases a little of the oil is added with each layer of manure.

Planting the spawn.—Cultivated mushroom spawn, used for planting ie beds, may be obtained from nearly any seedsman in the form of ried manure bricks. Before using, it should be broken up into pieces bout 2 inches in diameter. These pieces are planted in the bed 8 to 10 iches apart by making a suitable hole about 2 inches deep and pressig the spawn firmly into it. The hole should then be again filled with ie manure and packed down firmly. The bed is then covered loosely rith excelsior or straw to retain the moisture and to prevent a too apid fall of temperature. At the end of about a week this material s removed and the beds are then covered over with an inch to an inch nd a half of rich loamy soil.

The object in casing the beds with soil is to retain the temperature within the naterial, which is necessary for the maintenance of the growth, and it also provides firmer and cleaner substratum in which the stems of the mushrooms are mostly formed and they are thus cleaner when picked. In from 6 to 7 weeks mushrooms should begin to appear.

Harvesting and yield.—Mushrooms are ready to pick about the time the gills beneath the umbrella portion are a bright pink color. They remain in an edible condition until the gills become dark brown or even black, providing they are not decayed. If a hole is made in the bed in removing the mushrooms it should be filled in again with soil. The beds will need an occasional sprinkling with tepid water, but should not be made very wet. Too much moisture causes the mushooms to damp off or rot.

The yield of mushrooms at the New York Cornell Station was at the ate of about 2 pounds per square foot of surface. The manure for he beds was composted the last of October and the beds spawned November 23. The first mushrooms were picked January 1, or about weeks after spawning the beds. A week later regular picking began, nd the beds continued in bearing for about 3 [illegible]

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[a] For a further account of mushrooms, see also U. [illegible]

ONION CULTURE IN THE SOUTHWEST.[a]

Some interesting details of practical value relative to cultural methods and irrigation for onions, especially for regions of deficient rainfall, have recently been reported in bulletins from the Texas and New Mexico experiment stations.

The work reported from Texas by J. K. Robertson and E. C. Green was carried on in the southern part of the State at the substation at Beeville, where fair crops of onions are secured without irrigation. The purpose of the experiment was to determine the relative cost and yields of irrigated and unirrigated onion crops. The seed was started in beds and later transplanted to the field. At transplanting time the tops were cut back to about 5 inches, as shown in figure 4, and the roots trimmed to about three-fourths inch long.

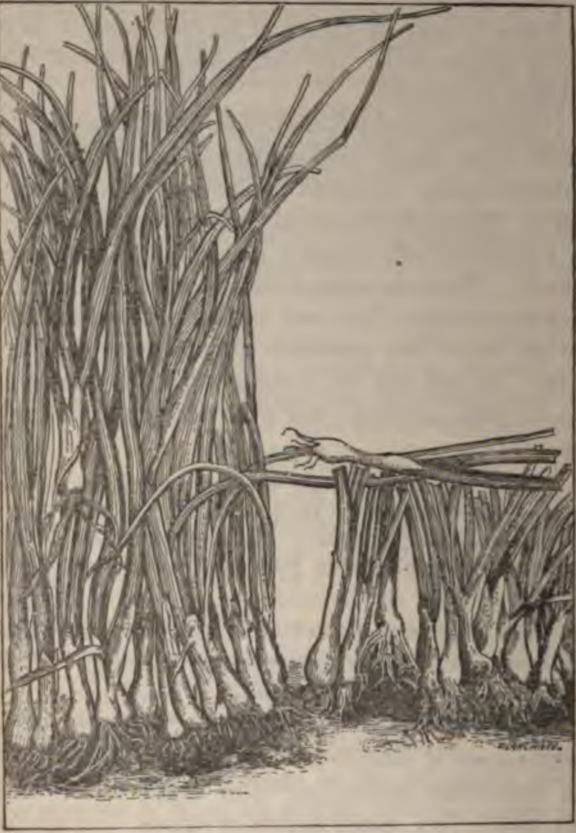

FIG. 4.—Onions trimmed for transplanting.

The soil was a rich black loam containing some sand. It was prepared by plowing, in September, 7 inches deep with a disk plow. On December 17 it was again plowed 6 inches deep and harrowed. On January 30 furrows 2.5 feet apart were laid off, and water applied over the whole field at the rate of 40,000 gallons per acre. Three days later the field was leveled, cultivated, and planked. The following day the onions were set out. From then on until the first of May, or about a week before harvesting, frequent shallow cultivation, about 1.5 inches deep, was given. In all, eight cultivations and one hoeing were given. The aim was to keep the ground broken up after each rain and maintain a dust mulch to preserve moisture. The preliminary irrigation over the whole field was necessary because of an unusually prolonged drought. Ordinarily it would not be needed. One part of the field received no further irrigation. The other part was irrigated four times, using water at the rate of 30,000 gallons for the first three irrigations and 40,000 gallons for the last. The rainfall from November 5 to May 6, when the crop was harvested, was 8.23 inches.

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[a] Compiled from Texas Sta. Bul. 77; New Mexico Sta. Bul. 52.

The cost of growing onions without irrigation was at the rate of $72.86 per acre, and the yield obtained was at the rate of 350 bushels per acre. With irrigation the cost was at the rate of $97.96 per acre and the yield at the rate of 676 bushels per acre. Irrigation in this instance increased the yield 326 bushels per acre at an increased cost of only about $25.

In this experiment the engine used for pumping water was insufficient, and at times the crops suffered from need of moisture. Otherwise, it is believed there would have been a still greater difference in yield in favor of irrigation.

Tests of varieties of onions suitable for the district have been made for a number of years at the station, the results of which show the Bermudas to be the most desirable and profitable, the red Bermuda giving uniformly the best satisfaction.

Sowing onion seed in beds or cold frames and later transplanting to the field has also been found by F. Garcia to be more satisfactory in New Mexico than sowing the seed in the field. However, practically all the onions now grown in New Mexico are from seed sown in the field. When sown in beds and transplanted from 3 to 4.5 pounds of seed are required, while if the seed is sown directly in the field 4 to 6 pounds are required. At that station it has been found better to transplant the latter part of February or early in March, even if the onions are only one-half as large as a lead pencil, than to wait until later in the season. It has been found that a boy can drop the onions for about three planters. A good planter will set 5,000 plants per day. With hand cultivation it is recommended that the rows be about 15 inches apart and the onions set 4 to 4.5 inches distant in the row. With horse cultivation the rows should be about 30 inches apart. The relative merits of these two methods of culture have been discussed in an earlier bulletin of this series.[a] The average estimated cost at the station for transplanting, for a period of three years, has been about $30 per acre, while the cost of thinning onions grown from seed in the field has been $41 per acre.

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[a] U. S. Dept. Agr., Farmers' Bul. 149.

In the region of the New Mexico Station the rainfall is so light that onions can not be grown without irrigation. The following suggestions are therefore made relative to irrigation:

> Immediately after the onions are set out they must be irrigated, and this should be followed with a second irrigation in about 7 to 8 days. Usually it takes about two irrigations to establish the little plants. The subsequent irrigations will vary more or less, depending on the soil and climatic conditions. Other things being favorable, the time between the irrigations to get good results should be about every 8 to 12 days. Since the onion is a surface feeder, it is very desirable that the upper portion of the soil be kept moist and cool. If possible, the plats should be arranged so that any excess of water may be drained off after each irrigation, especially on adobe soils. Care should also be taken not to allow the water to stand too long on the land. The soil must be kept uniformly moist throughout the growing period of the onion. If the soil becomes so dry that the plants stop growing and is then irrigated, the tendency is for many of the onions, especially if this occurs after the bulbs have made a considerable growth, to split into two or more parts. If this occurs, a part of the crop is liable to become unsalable.

Light and frequent irrigations are preferred to heavy irrigations at long intervals. Good results have been secured when very muddy water was used for irrigating purposes.

The yield of different varieties at the station in 1903 without fertilizers was at the rate of 32,000 pounds per acre for Red Victoria and 29,000 pounds for Prize Taker. In 1904 the variety Gigantic Gibraltar without fertilizer yielded at the rate of 31,250 pounds per acre. When nitrate of soda was used at the rate of 600 pounds per acre with this variety the yield was 40,450 pounds, an increase of 9,200 pounds per acre due to the use of nitrate of soda. The cost of growing an acre of onions in New Mexico varied from $107 to $111.75 per acre without fertilizers. The cost of cultivating and irrigating alone averaged about $30.

THE USE OF ETHER IN FORCING RHUBARB.[a]

Most of our northern flowering shrubs shed their leaves in the fall and ripen up their wood in preparation for a winter resting period. In 1893, Johannsen, of Denmark, discovered that if such shrubs were subjected to the fumes of ether for a certain time at the beginning of the resting period they could be placed in the greenhouse immediately thereafter and forced at once, coming into bloom about a month earlier than they otherwise would. This fact has been found of considerable commercial importance to European florists, who are more and more using this method for securing extra early blooms, especially with lilacs.

Recently W. Stuart, of the Vermont Station, has reported results of experiments in forcing rhubarb by the aid of ether fumes.[b] In these experiments the roots were dug in the fall and allowed to freeze. About mid December they were put in a cool cellar, where they thawed out gradually, after which part of the roots were subjected to the fumes of ether and part left untreated for comparison. The roots were etherized for forty-eight hours in an air-tight box, using ether at the rate of 10 cubic centimeters per cubic foot of space. The method of applying was to pour the liquid through a small hole in the cover of the box into a vessel suspended beneath the opening, after which the hole was immediately closed. Three other lots of roots were later etherized in the same manner, one lot January 9, another January 30, and the third February 24. With the roots treated January 30, 17 cubic centimeters of ether per cubic foot of space was used. This was later found to be too much, as the plants were injured by the treatment.

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[a] Vermont Sta. Rpt. 1904, p. 442.

[b] The Rhode Island Station has reported the results of forcing rhubarb in cellars in winter, as stated in U. S. Dept. Agr., Farmers' Bul. 107, p. 13.

Comparing the three lots, which were all treated with like amounts of ether, the following results as regards early and total yield were obtained:

Yield of rhubarb treated with ether fumes.

Treatment.	First picking.	Second picking.	Third picking.	Total.	Gain by etherization.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Per cent.*
Lot 1:					
Etherized December 20	454	681	340	2,294	34.4
Not etherized	69	246	378	1,707	....
Lot 2:					
Etherized January 9	270	449	608	1,914	89.7
Not etherized	....	209	395	1,009	....
Lot 4:					
Etherized February 24	21	343	189	553	5.7
Not etherized	34	336	153	523	....

The table shows that the etherized plants gave the largest total yield in every instance. This is not marked in the case of the lot etherized February 24. The exception in this case was not unexpected, since European experiments with other plants have shown quite uniformly that the later etherization is deferred during the resting season the less effect it has. Plants that have completed their resting period have not usually been benefited at all by etherization.

If early yields are considered, the average of the three lots shows an increased gain in earliness of the etherized plants of 622 per cent for the first picking, 86 per cent for the second, 23 per cent for the third, and 47 per cent for the fourth. The more rapid growth made by the etherized plants may be plainly seen in figure 5, which shows the condition of the etherized and unetherized plants just before the first picking was made.

In summing up the results of the season's work it would seem quite evident that there was a decided impulse given to the ether-treated dormant plants. This quickening of the vital processes in the plant resulted [illegible] h and a decided increase in weight of product. From the data at hand it would seem reasonable to assume that even more satisfactory results might have been attained had the work been undertaken a month or six weeks earlier. It is probable also that etherization of the plants would serve the same purpose that freezing does and in addition produce a greater growth.

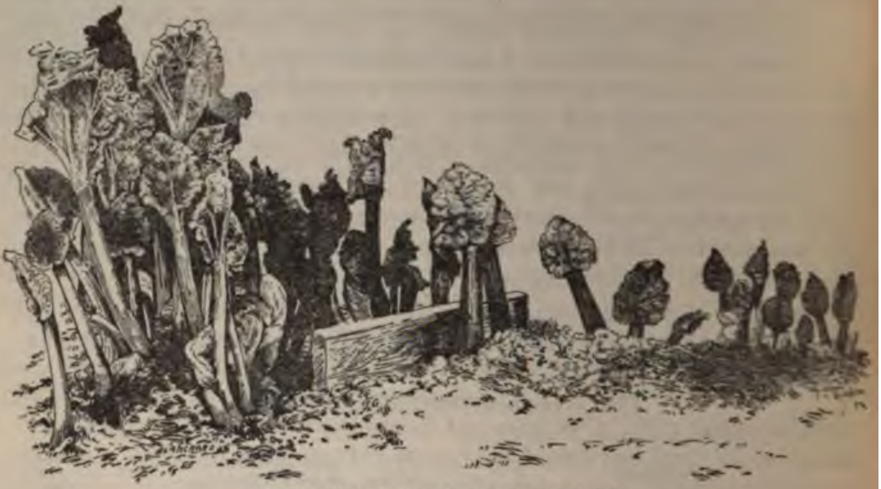

FIG. 5.—Etherized and untreated rhubarb.

Caution must be observed in the use of ether fumes, since the gas readily explodes if brought in contact with a light fire.

NOODLES.[a]

A report of the Connecticut State Station states that "noodles are prepared by European housewives and some manufacturers from flour, with the addition of a certain amount of eggs and salt. The dough is rolled into sheets and cut into strips or fanciful shapes. Most of the noodles on the market, however, although of a golden yellow color, are not made with eggs, but have about the same composition as macaroni, being dyed either with a vegetable color (commonly turmeric) or a coal-tar dye."

Twenty-two samples of noodles were collected and analyzed by the station during 1904, and all were found to "contain foreign coloring matter, which in twelve cases was turmeric and in ten cases was an azo color," evidently added with the intention of conveying the impression that the noodles were made with eggs, or contained a greater amount of eggs than was actually used.

The average composition of the noodles examined was water 12.94 per cent, ash 0.88 per cent, protein 13.46 per cent, nitrogen-free extract (carbohydrates) 71.89 per cent, and fat 0.83 per cent, or about the same as macaroni and but little different from that of the wheat flour from which it is prepared. Few of the samples examined showed any evidence of the use of an appreciable amount of egg in their preparation.

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[a] Compiled from Connecticut State Sta. Rpt. 1904, pt. 2, p. 138.

CONDIMENTAL FEEDS AND CONDITION POWDERS.[a]

A recent bulletin of the New Jersey Stations states that an examination of experiment station literature shows that hundreds of different brands of condimental feeds and condition powders are found in the markets of the United States, and that their number and the feeders using them are constantly increasing in spite of the fact that "the virtues and the failings of these preparations have been discussed many times by various investigators in this country and Europe, and their excessive cost and the doubtful benefits attendant upon their use clearly pointed out.[b] * * *

"The increasing use of these materials led [the] station in its 1904 inspection to collect all the different brands its inspector could find on the New Jersey market; as a result 50 different brands were found." Comprehensive microscopical and chemical analyses of these showed that they generally consisted of some well-known feeding material like linseed meal, wheat feed, or corn meal as a base, to which had been added varying amounts of vegetable or mineral drugs, ground bone, oyster shells, or some makeweight.

"The purpose of the use of drugs in these mixtures in most cases is to create an appetite, to tone up the system, or to act as a corrective on the bowels of the animal." It should always be borne in mind, however, that "animals in good health require no medicine; in fact, the excessive use of medicine with well animals frequently induces disorders. * * *

A loss of appetite, or a run-down condition induced by overwork or insufficient feed, may often be remedied by the use of a stimulating or tonic food, the ingredients for making which the feeder should always keep at hand. In the majority of cases simply a change of food will bring about the desired effect, but when this is ineffective a liberal use of common salt in the ration will generally prove beneficial. In the case of horses the use of linseed meal will be frequently found of marked benefit as a laxative.

The claims of the manufacturers of condimental feeds when not preposterous are exaggerated and misleading. No one feed, however skillfully compounded, can serve as a remedy for all the ailments of all classes of live stock.

Instead of being prepared according to scientific formulas as claimed, many of the condimental feeds are heterogeneous mixtures, with little regard to the requirements of the animal, and in certain cases the drugs used have a counteracting effect on each other.

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[a] Compiled from New Jersey Stas. Bul. [illegible]

[b] See U. S. Dept. Agr. Farmers' Bul. [illegible]

Even where effective drugs have been used the amount of the mixture to be given to the animal, according to the instructions of the manufacturer, is generally so small that no possible benefit can be expected from its use.

Assuming that the condimental feeds are scientifically prepared mixtures of useful and effective ingredients and their use as directed would confer upon the animal the benefits claimed, their excessive cost would prohibit their use by the careful and economical feeder. Such ingredients [as] they contain which might be of benefit any feeder can obtain and mix for himself at from one-tenth to one-twentieth the cost of the prepared foods. He would have the added advantage of knowing just what drugs he was administering to his animals and could give them such quantities of the needed medicines as veterinary experience has shown to be necessary.

BEEF TYPE v. DAIRY TYPE FOR BEEF PRODUCTION.[a]

The Iowa Station has recently reported the results of a year's feeding test to determine the relative economy for beef production of the beef and dairy types of cattle, a question which is receiving much attention at the present time. The results attained are summarized as follows:

Dairy type steers show a considerably higher percentage of offal and a lower dressing percentage.

Dairy type steers carry higher percentage of fat on internal organs, thereby increasing the total weight of cheap parts.

Beef type steers carry higher percentage of valuable cuts.

Beef type steers furnish heavier, thicker cuts; they are more evenly and neatly covered with outside fat, show superior marbling in flesh, are of a clearer white color in fat, and a brighter red in the lean meat; but there is little difference in fineness of grain.

The low price paid for dairy steers may be due partially to prejudice, and to the greater expense of carrying and selling the lower-grade carcasses; but it is chiefly due to an actual inferiority in the carcasses.

It is neither profitable nor desirable to feed steers of dairy type for beef purposes. They are unsatisfactory to the consumer because they do not furnish thick and well marbled cuts; they are unsatisfactory to the butcher because they furnish low-grade carcasses which are difficult to dispose of, and they are decidedly unsatisfactory to the feeder, because they yield him little or no profit, and both breeder and feeder waste their time in producing such a type of steer for beef purposes.

METHODS OF FEEDING SKIM-MILK CALVES.[b]

The increased use of milk separators in the dairy sections of the country has resulted in greater attention being paid to raising calves on skim milk. It is well settled at this time that practically as large, strong, and vigorous calves can be grown on skim milk supplemented by some suitable grain feed as on whole milk, providing they are properly fed and cared for.

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[a] Compiled from Iowa Sta. Bul. 81.

[b] Compiled from Idaho Sta. Bul. 48; Iowa Sta. Bul. 35; Kansas Sta. Buls. 97, 119, 16; Nebraska Sta. Buls. 68, 87.

ere is no question but that whole milk is the normal food for s, and when the cream or butter fat is removed it becomes neces- to replace it in the calf ration with some equivalent but cheaper of feed. A number of the stations have made experiments with rent feeds to learn which is most efficient for this purpose. Corn has been found the cheapest and best supplemental grain for purpose at the Iowa Station. Whole corn and Kafir-corn meal given good results at the Kansas Station. At the Nebraska on germ-oil meal and linseed meal have proved efficient substi- s, and in a recent bulletin of the Idaho Station good gains with are reported.[a]

he method of procedure in rearing the skim-milk calf at the sas Station was about as follows: The calf was allowed to run with mother the first 4 or 5 days of its life. It was then removed and twenty-four hours without food, when it became hungry and was ly taught to drink. For a week thereafter it was fed whole milk he rate of 4 pounds in the morning, 2 pounds at noon, and 4 pounds ight. The second week about the same amount of milk was given two feeds, morning and night. Within two or three weeks after oval from the cow, skim milk was gradually substituted for whole lk at the rate of a half pint per feed until the entire amount was im milk. About a month after the calf was taken from the cow was receiving 12 to 14 pounds of skim milk; at two months, 18 unds, and finally reached 22 to 24 pounds per day.

The grain added to the ration was fed dry in boxes. The calves gan to eat grain when 10 days to 2 weeks old. At first a handful s put in the calf's mouth as soon as it had finished drinking its milk, nd it soon learned to eat with a relish from the feed boxes. The afir-corn meal or other grain was never mixed with the milk. The lves were fed what grain they would eat up clean.

When the calves were 10 days to 2 weeks old they began to nibble hay nd were thereafter fed all they would eat. The hay was given fresh wice daily. Some hay from mixed grasses is considered best, with bright prairie grass a close second. Clover and alfalfa may be gradually added to the ration after the calves are several weeks old. Alfalfa alone was found to be too loosening for young calves. Changes from dry hay to pasture must be made very gradually or the calves are almost sure to have scours. This is done by turning them onto pasture for only a short time the first day and gradually increasing the period, or by mixing increased amounts of green feed with their hay until they are getting about all they will eat.

The most convenient way of feeding the calves has been by putting them in stanchions. Here they were kept for a half hour after feeding until their mouths dried out and they had lost their desire to suck each other's ears. Fresh water was kept within reach of the calves all the time, and it was surprising to find how many times a day the calves took a sip.

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[a] See also U. S. Dept. Agr., Farmers' Bul. 92, p. 21, for supplements to skim milk in feeding calves, and Bul. 84, p. 22, for experiments in Utah in rearing skim-milk calves.

Calves thus treated made an average gain of 1.58 pounds daily up to 5 months of age, results which are considered satisfactory. The cost of the gain in one test was at the rate of $2.26 per 100 pounds for skim-milk calves, $7.06 for calves fed whole milk, and $4.41 for calves running with their dams. When put in the feed lots the skim-milk calves made better gains than either of the other two lots.

Calves fed sterilized creamery skim milk made as good gains as when fed hand-separator skim milk. A proprietary calf meal and flaxseed meal were fed in addition to grain, but they did not increase the efficiency of the ration, besides being expensive and practically useless. No advantage resulted from adding rennet to the ration. Calves fed on buttermilk made average daily gains of 1.79 pounds per head as compared with 2.02 pounds for calves fed skim milk and were less subject to scours. Calves on whey made satisfactory gains where care was taken to feed suitable grain and hay rations in addition. Calves made better gains on shelled whole corn than on corn chop. With Kafir corn, however, the best gains were made on the ground grain. A mixture of corn and ground Kafir corn gave better results than either fed separately.

The management in the early stages of weaning the calf and substituting skim milk for whole milk at the Idaho Station was practically the same as at the Kansas Station. As soon as the substitution of skim milk for whole milk begins, the teaching of the calf to eat whole oats was undertaken. This was done by placing not more than a tablespoonful in the box in front of the calf after it had drunk the milk. In nosing about the calf got some of the oats in its mouth and in a very short time learned to like them.

> Whole oats are preferred to rolled or ground oats, for the husk of the oat is then so thoroughly attached to the grain that it will be masticated with the kernel and the calf having sharp teeth will have no difficulty in grinding it. The ration of oats will be gradually increased as more of the whole milk is withheld and separator milk substituted until at the end of three or four weeks the calf will be getting half a pint twice a day. The amount depends on the calf, for some animals will eat the oats more readily than others. * * * After the calves have finished the ration of oats, which requires an hour or so, they are released [from stanchions] and allowed to pass into a box stall. This stall is provided with feed racks about the walls which are filled with the choicest hay the farm affords. The calves, even those only 5 or 6 days old, soon learn to pick this tempting bit of hay instead of sucking each other's ears, as they are apt to do when fed in the ordinary way.

Quite a difference was found by the station in the quality of oats for calves. Oats with a thin hull have been found best. Large, coarse, thick-hulled oats were not so readily eaten and appeared to injure the calf's mouth. The average gain for the first 150 days for the calves thus reared at the Idaho Station was at the rate of 1.59 pounds per head per day.

Calves brought up on skim milk are most unattractive from 6 to 12 months of age.

They develop a stomach out of proportion to the rest of their body and their coat is not quite as smooth as it is when calves run with their dams. However, the calves have learned how to eat and digest coarse feed in larger quantities than calves reared on whole milk. The digestive organs are better developed for practical feeding from this period on to maturity than in calves fed whole milk.

The following suggestions stand out prominently in the recommendations by the stations: Make the change from whole milk to skim milk slowly. Substitute about one-half pint of skim milk for whole milk at each feeding until the calves are wholly on skim milk. Do not feed too much milk. The milk should be fed warm and sweet. The right temperature is between 85° and 100° F., and this should be determined by a thermometer rather than by the hand. The grain should not be mixed with the milk, but be fed dry after the milk has been drunk.

Undoubtedly the greatest difficulty that the calf feeder has to contend with is scours. Here, as elsewhere, "an ounce of prevention is worth a pound of cure." The principal causes of this difficulty are overfeeding, sour milk, feeding cold milk, feeding grain with the milk, using dirty milk pails, very cold water, too much water after periods of thirst, and irregularity in feeding. The careful feeder will watch very carefully the effect of his feed upon his calves, and as soon as there are any signs of scours the milk should be reduced one-half or more and gradually increased again as the calf is able to stand it.

The Kansas Station has been very successful in using dried blood as a tonic for weak or scouring calves. A mild case of scours can usually be cured in from one to two days by reducing the milk and adding a teaspoonful of dried blood while the calf is drinking. * * *

In severe cases of scours the addition of one or two eggs with the dried blood has been found to be very effective. Another remedy that has been found to be successful is to give from 1 to 2 ounces of castor oil in the morning and follow in about twelve hours with 15 to 20 drops of laudanum and a teaspoonful of dried blood. If the case is a persistent one, one or two raw eggs may be added.

ANIMAL FOOD FOR DUCKLINGS.[a]

In an earlier number of this series[b] it was shown that, practically speaking, rations for ducks must contain some animal food. How much animal food it is best to give has been made the subject of further investigations by W. P. Wheeler, of the New York State Station. In a preliminary trial the station found that ducklings grew well for four weeks on a ration of which 94 per cent of the dry matter and 98 per cent of the protein was derived from animal sources. The cost however, was high. As the birds grew older the rate of gain became lower and the cost of production excessive. The experiment is interesting as showing how large a proportion of the ration fed to ducklings may consist of animal food without injury.

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[a] Compiled from New York State Sta. Bul. 259.

[b] U. S. Dept. Agr., Farmers' Bul. 97, p. 17.

In a second experiment four lots of ducklings consisting of twenty-eight birds in each lot were fed for ten weeks a basal ration of grain so supplemented with animal meal and other foods that about 20 per cent of the protein in the ration of lot 1, 40 per cent of lot 2, 60 per cent of lot 3, and 80 per cent of lot 4 was derived from animal food. The gains made at different periods of growth, the amount of dry matter in the food required to produce a pound of gain, and the cost of the gains made are shown in the following table:

Average gain of ducklings on rations containing different proportions of animal food.

	Protein from animal products.	First 3 weeks of test.			First 7 weeks of test.			Entire 10 weeks of test.		
		Average gain.	Food per pound gain.	Cost per pound gain.	Average gain.	Food per pound gain.	Cost per pound gain.	Average gain.	Food per pound gain.	Cost per pound gain.
	Per cent.	*Oz.*	*Lbs.*	*Cts.*	*Oz.*	*Lbs.*	*Cts.*	*Oz.*	*Lbs.*	*Cts.*
Lot 1	20	15.9	2.5	3.6	56.3	3.0	4.2	71.7	3.9	5.4
2	40	19.1	2.2	3.3	64.2	3.0	4.6	78.8	4.0	6.0
3	60	22.5	2.1	3.3	68.4	3.0	4.7	82.7	4.0	6.2
4	80	20.8	2.3	3.8	66.2	3.1	5.2	78.7	4.2	7.0

The figures in the table show that throughout the entire test the most rapid gain was made by lot 3, where 60 per cent of the protein of the ration was derived from animal food, while the slowest gains were made by lot 1, which was fed the smallest amount of animal food. When the protein from animal sources was increased in the ration from 60 to 80 per cent, the gains were not so great; more food was required to produce a pound of gain, and the cost of the gains made was regularly higher throughout the whole period.

The table shows that the rations containing the larger proportions of animal food were most effective and most economically used during the early stages of feeding. Later on the rations containing the larger proportion of grain were fully as effective and considerably cheaper than those containing large amounts of animal food. Where it is desired to prepare birds rapidly for market, the ration containing the larger amount of animal feed is most efficient, and in certain cases this rapidity of growth may offset the increased cost of the larger meat ration.

So far as this one experiment goes, it seems from a study of the results that it will pay to feed freely of animal food during the first three to five weeks, and depend after that more on increasing proportions of the cheaper grain foods. The exact proportions most profitable to use will vary considerably at different times according the food supply and the demand for the product.

MILK FROM DISEASED COWS.[a]

One of the most characteristic constituents of pus is the white blood ell or corpuscle, known technically as a leucocyte. Outside of the lood vessels these cells are found normally in various tissues and uids of the body and so have gained the name of wandering cells. hey are found abnormally and generally in large numbers wherever here is inflammation. They have been found in milk, and so the uestion has naturally been considered if their occurrence in milk ndicates an inflamed or diseased condition of the udder. Information n this subject is contained in a recent bulletin of the Maryland Agri-ultural Experiment Station by C. F. Doane.

A method of counting leucocytes in milk was devised at the station nd two large well-kept dairy herds were then systematically investi-ated. Leucocytes were found in the milk of every sample examined. heir numbers for individual cows ranged from 2,000 to 4,600,000 per ubic centimeter. As most of these cows at least must be considered s unquestionably in a state of perfect health the mere presence of eucocytes in milk does not therefore signify disease in the animal. wing to the wide variation in the numbers of these leucocytes Doane onsiders it questionable if an arbitrary standard can be maintained eyond which it is safe to say that the milk contains pus, or in other ords, that it is from a diseased cow and hence unfit for use. It was bserved, however, that the milk of cows affected with garget showed n all cases a high leucocyte count, while the milk of healthy cows as often very low in the number of these cells.

Pursuing these studies further, Doane observed certain threads in us which were identified as fibrin, and he was also able to find the ame threads in the milk of diseased cows. In such samples of milk he fibrin threads and the leucocytes were present in masses or clumps. Vhen the number of leucocytes in any sample of milk was low, no uch clumps of leucocytes and fibrin were found. When the number f leucocytes was high, clumps were often present. A high leucocyte ount would therefore render a sample of milk suspicious, and the resence of fibrin in addition, as shown by a clumping of the leucocytes r as demonstrated by staining the threads, would in the opinion of Doane furnish satisfactory proof that inflammation exists in the udder, nd in such cases the milk of course must be considered unfit for use.

It is in reality not so much the purpose of this note to present the microscopical leucocyte-fibrin test of Doane, for whether or not this will prove of practical value in detecting the milk of diseased cows remains to be seen, but to call attention to a growing interest in the production and sale of clean, wholesome milk, and to this end methods of inspection are being studied and applied. It behooves the d man to comply with the requirements of sanitary milk production the consumer to insist upon the observance of these requirements

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[a] Compiled from Maryland Sta. Bul. 102.

CIDER VINEGAR.[a]

Vinegar is made from a number of different products. The quality is made from fruit juices; cheaper grades are made from malt, grains, and sugar refinery wastes and other sources. cheaper kinds are often colored and otherwise "doctored" and sold as cider vinegar. In order to prevent this fraudulent prac number of States have passed laws establishing certain standard vinegar. These laws are not entirely uniform. The minimum amount of acetic acid for cider vinegar is placed at 4 per cent in States, in others 4½ per cent, and still others 5 per cent. The solids likewise required vary in different States from 1½ to 2 per

Under faulty methods of preparation it is not uncommon for gar made entirely from cider and wholly unadulterated to fall these requirements. It therefore becomes important to note wh best methods of making vinegar under ordinary farm condition The stations in Virginia, New York, Pennsylvania, and Oregon all reported the results of valuable researches along this line, ar following account is based on their work.

Normal changes in vinegar production.—There are two imp changes which take place in the conversion of fruit juice into vi First, the sugar in the juice is converted into alcohol, and, sec the alcohol is converted into acetic acid. In these transformatio parts of sugar in the juice should produce theoretically about 51 of alcohol; that is, one should obtain about half as much alco weight as there was sugar in the juice. In practice only from 47 per cent is actually obtained. In the conversion of alcoh acetic acid 100 parts of alcohol should yield theoretically 130 p acetic acid, but less than 120 parts are actually obtained. Sta therefore, with 100 parts of sugar in the fresh apple juice, under able conditions we should obtain from 50 to 55 parts of aceti To make vinegar, therefore, which shall contain 5 per cent of acid it will be necessary to have juice containing at least 10 pe of sugar. For 4½ per cent vinegar, apple juice analyzing at le per cent of sugar will be necessary.

The composition of apple juice.—The juice of ripe apples has found to vary in sugar content from 7 to 15 per cent, the avera large number of varieties in different States being nearly 11 per cent. nalyses reported by the Virginia Station indicate that summer apples re on the average lowest in sugar content, winter apples highest, and all apples intermediate. Mature ripe apples contain the largest mount of sugar; green apples contain a much smaller quantity, and verripe apples contain less sugar than ripe apples. Contrary to the sual belief, sweet apples are ordinarily no richer in sugar than sour pples. They taste sweet because they contain less malic acid than our apples. Malic acid is the normal acid of apples. In vinegar making this acid disappears quite completely, decreasing in the case of xperiments at the New York State Station from 0.55 per cent in fresh uice to 0.02 per cent at the end of twenty-four months, and in some lder vinegars it had disappeared entirely.

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[a] Compiled from New York State Sta. Bul. 258; Virginia Sta. Buls. 57, 71, 1 137, 138; Oregon Sta. Bul. 73; North Carolina Sta. Bul. 182; Pennsylvania De Buls. 22 and 58, Rpt. 1899, p. 541, 1901, p. 128; Pennsylvania Sta. Rpt. 1902, Jour. Amer. Chem. Soc., 25 (1903), No. 1, p. 16; U. S. Dept. Agr., Bureau of istry Bul. 88.

Alcoholic fermentation.—In ordinary cellar storage it takes from one o six months for all the sugar in cider to become converted into alcohol. The more important factors affecting the rapidity of the transformation of sugar into alcohol are temperature and the presence of yeast. With a cellar temperature of 45° to 55° F. at the New York State Station it was six months before alcoholic fermentation was completed. In another cask kept at 85° F. alcoholic fermentation was completed in three months.

Alcoholic fermentation is caused by a vegetable ferment or enzym which is produced by ordinary yeast. Cells of the yeast plant are so widely distributed that they get into apple juice abundantly under ordinary conditions.

At a temperature of 65° to 75° F. the yeast plant grows much more rapidly than at lower temperatures. Hence fermentation is much more rapid. At a temperature much higher than this there may be a loss of alcohol by evaporation. The stations have found that the period of alcoholic fermentation can be readily reduced one-half or more by the addition of yeast to the fresh juice, especially if the cider is kept at a temperature of 65° to 75° F.

Acetic fermentation.—After alcoholic fermentation is completed another group of micro-organisms attack the alcohol and convert it into acetic acid. The acetic fermentation takes place much more slowly than the alcoholic, requiring eighteen months to two or three years before all the alcohol is changed into acetic acid when the cider is kept in ordinary cellar storage. The most satisfactory results of acetic fermentation were obtained at the New York State Station at temperatures of 65° to 75° F. When the micro-organisms causing acetic-acid fermentation were introduced into the cider at that station in the form of vinegar or "mother" after the alcoholic fermentation had been completed, the conversion of the cider into vinegar was much more rapid than where no addition of vinegar was made.

In a cool cellar, cider that had thus been inoculated by the addition of cider vinegar or "mother" reached marketable condition a year sooner than where the vinegar was not added. Vinegar should never be added to cider that has not completed its alcoholic fermentation, since the presence of the acetic acid greatly retards alcoholic fermentation. On this point Browne, of the Pennsylvania Station, states as follows:

> Many farmers and vinegar manufacturers make a foolish practice of adding fresh apple juice to old vinegar stock in the hope of thus securing a more rapid conversion of the product into vinegar and then complain that their vinegar "won't make." The sugar of the juice must first undergo the alcoholic fermentation before the acetic fermentation can begin, and by adding apple juice to old vinegar the alcoholic fermentation may not only be checked but even absolutely prevented.

The organisms causing acetic fermentation require abundance of air in order to do their best work. The practice, therefore, of inserting an empty bottle in the bunghole of a barrel intended for vinegar is useless and injurious, as it prevents the free entrance of air, which is necessary for the growth of the acetic micro-organism. After acetic fermentation is completed the organisms are no longer needed. Barrels containing vinegar should then be filled full and tightly bunged, otherwise these organisms or others of a like nature may attack and destroy the acetic acid already formed, rendering the vinegar weaker or entirely worthless. At the New York State Station some of the uncorked vinegar finally actually became alkaline.

Suggestions for making vinegar.—The foregoing facts relative to the alcoholic and acetic fermentation lead to the following practical suggestions on vinegar making: Use only ripe, sound fruit. If the fruit is dirty it should be washed, otherwise there is danger of introducing micro-organisms into the juice that will interfere with the normal alcoholic and acetic fermentation. For the same reason cleanliness should also be observed in grinding and pressing the fruit and in the handling of the juice.

For profit the pressing should be done with a power press. With a hand press only 2 gallons of juice per bushel of apples could be secured at the Virginia Station, while with a power press 4 gallons were obtained. Sometimes water is added to the pomace and a second pressing made. Such juice is deficient in sugar and will not make vinegar of a standard quality. When possible, the freshly pressed apple juice should be placed in some large receptacle and allowed to stand for a few days before putting into barrels.

> In this way considerable solid matter held in suspension will settle before the liquid is placed in casks. The casks used should be well cleaned, thoroughly treated with live steam or boiling water, and should not be over two-thirds or three-fourths filled with apple juice. The bung should be left out, but a loose plug of cotton may be placed in the hole to decrease evaporation and prevent dirt falling in. The bung should be left out until 4.5 to 5 per cent of acetic acid has formed.

hen fresh cider is placed in barrels and stored in ordinary cellars, olic fermentation is not completed until the end of about six hs. With a cellar temperature of 60° to 70° F. this time can be derably reduced. If yeast is added to the fresh cider, fermenta- can be completed in three months or less. If compressed yeast ed about one cake to each 5 gallons of juice should be used after thoroughly softening the yeast with lukewarm water.

e New York State Station advises that after alcoholic fermenta- is completed the clear portion of the liquid be drawn off, the el rinsed out, and the clear liquid put back. From 2 to 4 quarts ood vinegar containing more or less "mother" should then be ed. If the barrel is stored in a cool cellar it will require twenty- to twenty-four months or more to change all the alcohol into acetic . If the alcoholic fermentation takes place in a cool cellar over ter and the barrel is moved into a warm place, as out of doors, ing summer the acetic fermentation may be completed in fifteen to hteen months. If the alcoholic fermentation is hastened by the ition of yeast and storage in a warm temperature, and the acetic mentation favored by the use of vinegar "starter," as noted above, is possible to produce good merchantable vinegar in six to twelve nths.

hen the acetic fermentation has gone far enough to produce 4.5 to 5 per cent of tic acid, then the barrels should be made as full as possible and tightly corked in er to prevent destructive fermentation of acetic acid and consequent deterioration the vinegar.

Rapid method of vinegar making.—The long time required to make negar by the cask and storage method, as described above, has led the use of vinegar "generators," by the aid of which the acetic fer- ntation can be completed within a few days or even hours. These enerators" consist, essentially, of an upright cask 3 to 6 feet in meter and 6 to 12 feet high. About a foot from the bottom of the k there is a perforated false bottom, upon which coiled beech shav- s which have been previously boiled in water, dried, and soaked for eral hours in old vinegar are placed. Another perforated disk is ced above the shavings and the top closed with a cover containing ole in the center, through which cider which has undergone com- te alcoholic fermentation enters. Just underneath the false bottom ow of holes slanting downward is bored around the cask for the mission of air.

In operation the liquid flows slowly through the opening in the top on the perforated disk where it is evenly distributed over the shav- s. The rate of flow is regulated according to the size of the gen- tor, but usually should not exceed 1 gallon per hour. The liquid ws in thin films over the shavings, coming in contact with the acetic- d ferment and large quantities of air, which rapidly convert the ohol into acetic acid. During the generation of vinegar the temperature inside the cask rises. This is recorded by a thermometer inserted in the shavings in the middle or near the top of the cask. A temperature of about 95° F. near the top has been found to give the best results. At a higher temperature some loss of alcohol may occur by evaporation. The temperature may be lowered by plugging up some of the air holes from below and thus decreasing the air supply.

Vinegar thus made is likely to be more uniform in composition than that made in casks.

> It is admitted, however, that generator vinegar, in aroma and flavor, is not equal to vinegar made by the longer process—the delicate and volatile ethers, which give the latter vinegar its peculiar properties, being the products of a slower and less violent fermentation. For a table vinegar the old process of fermentation is to be preferred, while for pickling and similar uses generator vinegar is no doubt as well suited as a product of the former kind.

The New York State Station notes that "in the hands of the ordinary farmer, making only a few barrels of cider, these generators would probably not be found entirely practicable in every way."

Vinegar from prunes.—Vinegar was made at the Oregon Station from undersized and otherwise unsalable prunes. The prunes were first washed and then run through a home-made machine with spike rollers, which lacerated and tore them. The pulpy mass was then inoculated with a pure culture of yeast (*Saccharomyces cerevisiæ*). This caused a strong and rapid fermentation, which broke down the cell walls of the prunes, thus liberating the clear juice, which flowed into a receptacle below the vat. This method of securing the clear liquid was inexpensive and very satisfactory. A little more than 3 gallons of juice was secured per bushel of fruit. The juice was fermented in open barrels. Fermentation was completed in ten days, when the juice was found to contain 10 per cent of alcohol. It was then inoculated with a pure culture of vinegar ferment (*Bacillus pasteurianus*) by floating it on the surface of the liquid by means of pieces of cork weighted so as to bring the culture in contact with the liquid.

The vinegar thus produced was of excellent quality, with a fruity flavor and good body, and contained 6.89 per cent of acetic acid. The only objection to it was its color, which was that of very dark wine. It was, however, but little darker than imported malt vinegars, which find ready sale in Oregon markets. By the use of yeast for the alcoholic fermentation and the addition of vinegar "starter" after th acetic-acid fermentation, pear vinegar containing 8.89 per cent aceti acid and apple vinegar containing 6 per cent have been made at th station within four months from the time the fruit was pressed.

The station states the essentials of vinegar making, thus:

> The barrels must be free from must and mold, the depth of the liquid should n exceed the surface measure, free air must be continually admitted, an even, war temperature should be maintained, and, last but not least, the fruit that is us should be free from decay and mold.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 234.

E GUINEA FOWL AND ITS USE AS FOOD.

BY

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WASHINGTON:
GOVERNMENT PRINTING [illegible]
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Experiment Stations,
Washington, D. C., October 3, 1905.

Sir: I have the honor to transmit herewith, and to recommend for lication as a Farmers' Bulletin, a summary of data on the feeding, nagement, and uses of guinea fowl, prepared by C. F. Langworthy, this Office, in accordance with instructions given by the Director. the United States there is a growing market for guinea fowl as le birds, and therefore it has seemed desirable to summarize the ailable data regarding them. At some of the American experiment tions studies have been made of the composition of the flesh and gs of this class of poultry, but so far as can be learned no tests ve been made of their food requirements, the comparative value of fferent rations, or the best systems of care and management.

Standard poultry books and files of poultry journals contain some ferences to guinea fowl and methods of feeding and caring for them, t the information thus available is meager and widely scattered. In e present bulletin such data have been summarized, as well as information secured by correspondence and in other ways. The discussions the preparation of guinea fowl and guinea eggs for the table, and e character and quality of the cooked products are in considerable rt based on experiments especially undertaken for this bulletin by achers of domestic science and others.

The list of those who have supplied data is large, and all are deserv- g of thanks, as the information received has been most useful.

Respectfully,

A. C. True,
Director.

Hon. James Wilson,
Secretary of Agriculture.

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THE GUINEA FOWL AND ITS USE AS FOOD.

INTRODUCTION.

uinea fowl, sometimes called guinea keets, belong to the natural ɔr of Gallinaceæ, which includes also our common fowl. As the lish name implies, the birds are probably natives of the west coast Africa, although some authorities urge that they are descended n a variety common in Abyssinia. They were raised as table birds he ancient Greeks and Romans, but disappeared from Europe dur- the dark ages, and were reintroduced later, it is said, from Jamaica Cuba. They were evidently taken to the West Indies by the y European settlers and have been abundant in several of the islands since. In Jamaica, in some of the lesser Antilles, and also in the e Verde Islands they have gone back to their wild state and are ted in their season as game birds. They are also well known as e birds in England, where large flocks are sometimes kept in game serves. Their quarrelsome nature, however, makes them the ene- s of other birds, especially of pheasants, and the two kinds can not ept together. On the Continent they are more common and more pletely domesticated, and are prized as table birds. In Austria cially there are large establishments devoted to their breeding, and nea fowl are also raised for market in considerable numbers in nce and Germany.

the United States very few breeders, if any, raise them in large bers. They are much more common in the Southern States than he North. A pair is occasionally seen wandering about New Eng- l farmyards—but less commonly now than a few years ago—and are raised in small numbers by many poultry men in the Middle st, as is shown by the fact that the market supply comes in con- rable part from that region. The chief objections to them seem to heir harsh cry, which is often particularly troublesome at night, their wandering and quarrelsome habits. While their cry is unde- ly disagreeable, it does not seem that it is very much worse than e of ducks and geese, and it is considered an argument in the birds' favor by many farmers, as it gives warning of marauders in the poultry yard. Similarly, their pugnacious disposition, while it occasionally leads to trouble with other poultry, also makes them show fight against hawks and other common enemies, so that guinea fowl are sometimes kept as protectors of the more peaceable birds.

There is no denying that if left to themselves guinea fowl are inclined to stray far afield and especially to "steal" their nests in out-of-the-way places; but, as will be shown later, they can with care be trained into more domestic habits. If they are allowed to range, their feed costs little, since they will live almost entirely on insects, seeds, etc. Both eggs and flesh are considered delicious eating in Europe, and, although many persons in this country rate them below chicken, and others have never tasted them, epicures consider them most excellent, ranking them with game birds. The demand for them in our city markets is constantly increasing, and it seems probable that they will soon be a recognized source of profit to the poultry man, fit to be bred, fed, and marketed as carefully as chickens, turkeys, ducks, and geese, and not merely as curiosities.

VARIETIES OF GUINEA FOWL.

There are several varieties of wild birds known as guinea fowl in Africa, some of which have very beautiful plumage. Among the most striking is the vulturine royal guinea fowl, which is seldom raised in captivity, though occasionally seen in collections of birds. The head and upper part of the throat are destitute of feathers. The nape of the neck is covered with short velvet-like brown down, and the lower part has long lanceolate flowing feathers, showing a broad stripe of white down the center, bordered with a line of dull black with small white dots, and margined with blue. The breast and sides of the abdomen are of a beautiful metallic blue, the center of the abdomen black, the flanks dull pink, with numerous spots of white surrounded by circles of black; the bill is brownish and the feet brown.

The true guinea fowl, Numidæ, include six species with naked heads covered on the top with a more or less elevated bony helmet, a pair of wattles at the angles of the gape, and black, white-spotted plumage. The common species (*Numida meleagris*), the ancestor of the ordinary domesticated birds, may be distinguished by its having a wide vinous gray collar covering the upper part of the mantle and chest. The bare skin on the sides of the face, neck, and chin, and also the wattles are red, and the rest of the neck a dark bluish color. The black, almost hair-like, feathers on the neck are continuous in a thin line nearly to the base of the helmet. The white spots on the mantle are smaller and less uniformly round than on the other species, and the wattles at the angles of the gape are wider. The helmet is horn-colored and the legs and the feet are a dusky red. The body, wing, and tail feathers all show the same markings, round white dots on a dark ground. In immature specimens many of the white spots are represented by bars and markings of white, this being especially true of the feathers on the wings, tail, middle of the back, and breast.

Domesticated birds of the ordinary type (fig. 1) appear to have been developed from a single variety or from several closely related varieties, and have undergone surprisingly little change either in appearance or in habits during many generations of captivity. There are not many varieties, and the so-called "pearl" guinea fowl is by far the most common. It has steel or purplish gray plumage regularly dotted or "pearled" with white (whence its name), and it is so handsome that the feathers are frequently used for ornamental purposes. The birds have bright coral-red wattles. The ears and the sides of the head are ordinarily white and are not unlike kid in appearance. Pure white guinea fowl are not uncommon and are sometimes considered a distinct type developed by domestication. It is probable, however, that they are albinos of the common variety. Other sports appear with white plumage dotted with black. By crossing these and the albinos with the regulation type, birds with variously mixed plumage have been obtained. Crosses between guinea fowl and other poultry, particularly chickens, and less commonly turkeys, are not unknown, such cross-bred birds being without exception sterile.

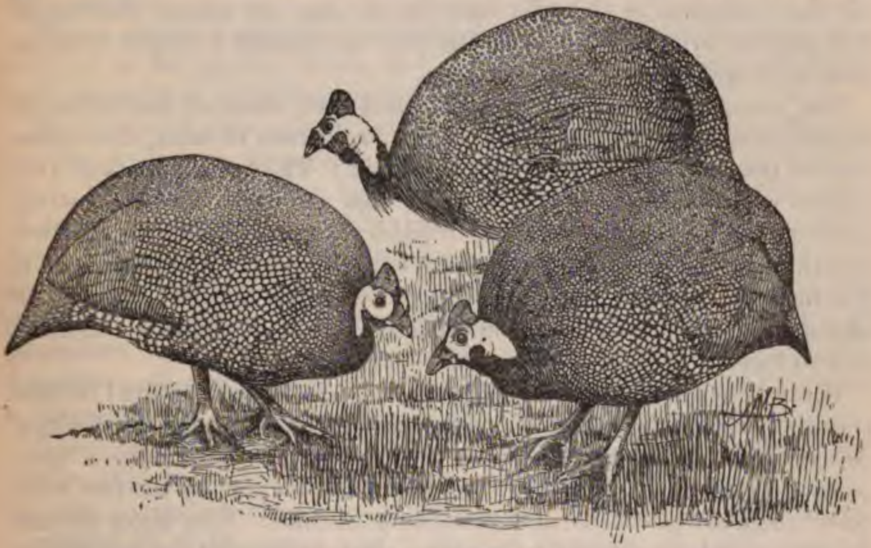

FIG. 1.—Common guinea fowl.

Of the common classes of domesticated guinea fowl some have a peculiar bony helmet on the top of the head, while with others this is replaced by a crest of feathers varying in size and shape in different types. In all varieties the male and female birds are very much alike in appearance. The males, however, may generally be distinguished by their larger comb and wattles and coarser heads and by a peculiar habit of "walking on tiptoes" when excited. The cries of the two sexes differ decidedly; that of the male is simply a shriek, while the female has a peculiar call, often thought to resemble "buckwheat, buckwheat." When angry they make a hissing cry.

It is stated that the most general change which domestication seems to have produced in the appearance of guinea fowl is in the color of the legs—whereas in the wild varieties the legs are almost uniformly dull gray or brown, in the domestic they are usually a bright reddish yellow or orange.

The young guinea chicks are very attractive, those of the ordinary variety resembling young quail. They are brown in color, the under part of the body being lighter than the rest. The back is marked and striped with yellow, and the bill and legs are red. The first wing feathers are brown, yellow, or reddish brown. When about two months old, the ordinary feathers replace the downy plumage, and a few months later the peculiar crest or comb and wattles make their appearance. At this period the birds are especially delicate and difficult to handle.

There is as yet no standard of perfection set for guinea fowl in this country, the birds not being recognized by the American Poultry Association. Here and there are poultry fanciers who make a specialty of guinea fowls, and the points insisted upon by the few who breed them are good size and uniformity in color. The latter should be gray, regularly marked with white, or the pure white of the albino type. Other sports and crosses between these two are as yet mainly curiosities, although in the absence of a recognized standard each breeder is at liberty to set up one to suit himself.

HABITS AND CARE.

In the wild state guinea fowl show a preference for forests and wooded valleys, and congregate in large flocks. Under less favorable conditions the flocks are much smaller and the birds range over large areas. In their natural habitat the food varies with the season. Thus in the spring they feed upon insects, and later, in summer, also upon leaves and shoots, buds, berries, and seeds of all sorts. In winter they seek cultivated fields and the foods which they afford.

As has already been indicated, the domesticated birds have retained a surprising number of their wild traits. If allowed to have liberty they wander over long distances, fly almost as well as if they had never known captivity, and prefer roosting high in trees to spending the night under cover. They make their nests, which are hardly more than a few twigs put over a hollow in the ground, in some secluded spot at a distance from habitations. They will desert a nest if they see a human being near it; and if it or the eggs in it are touched by the hand in their absence they are said to leave it at once. For this reason it is quite commonly believed that the eggs must be removed with a stick or a long-handled spoon. Some who are familiar with guinea fowl insist that care must also be taken to leave several nest eggs, as the hens will not usually lay again in a nest containing only one or two; one breeder considers five the smallest number which it is safe to leave.

When secluded nests are provided, however, guinea hens will generally lay in the poultry house, and if they have high perches and are fed regularly at night they will also roost at home.

In their wild state guinea fowl mate in pairs, and many, particularly earlier, writers on the subject recommend mating them thus in captivity. However, it is now customary to allow several hens to a cock. A prominent American breeder recommends three or four hens to one male if they are kept for breeding purposes. If the proportion of hens is too large the eggs tend to be infertile. If the birds are kept mainly to supply eggs for the table more hens may be allowed. If permitted to range, several cocks and their attendant hens will flock together and several hens will use the same nest, in which they pile a large number of eggs, sometimes as many as 30 or 40.

Their breeding season begins about the same time as that of wild birds—that is, in April or May, according to the latitude—and they usually continue laying throughout the summer. Breeders formerly expected 50 or 60 eggs a year from each hen, but the varieties have improved so much that 100 is now considered a reasonable number.

Though, generally speaking, the guinea hens lay only in summer, it is possible and indeed probable that they can be bred to lay in winter, which would be an advantage in raising early broilers for the market. It is reasonable to believe that modifications in methods of handling would induce winter laying, as this factor is known to have a marked effect with ordinary poultry.

Guinea hens make poor sitters, as they are restless and inclined to range when they should be on the nest. Sixteen eggs is said to be the proper number for a sitting, but as soon as two or three chicks are hatched the hen is likely to go off with them even if the other eggs are pipped and would hatch after a few hours more of brooding. For this reason breeders rarely leave the eggs to the mother hens when they become broody except late in the season. Incubators appear to have been used but little for guinea hens' eggs, though there is no reason to suppose they would not give satisfactory results. The usual practice is to put the eggs under a common hen, and she can easily cover 15. A German writer considers that turkey hens are best for hatching guinea eggs, though other poultry will also answer the purpose. He states that a turkey will cover 18 eggs. Guinea eggs are usually very fertile and the proportion which hatches is large.

The period of incubation is about a week longer than that of common chicks, and probably lasts twenty-eight days, although some authorities say twenty-six and still others thirty. A Russian investigator has made extended studies of the changes taking place in guinea hens' eggs during incubation, and has discovered some interesting biological differences between their development and that of common hens' eggs.

Newly hatched guinea chicks are hardly more than half as large as chickens, but run about with amazing agility almost as soon as they leave the shell. So inclined are they to use their legs and wings immediately that one authority recommends placing the nests in large boxes covered with netting. In any case they should be kept in close confinement for five days or a week or they will get lost. After that they may be allowed to run with the hen when the weather is good, and, if they are to range, may have full liberty when two weeks old. They are inclined to keep close to the brood mother for several months, and for this reason their natural ranging instincts can be considerably checked by giving them to a hen of home-keeping habits.

When the guinea hens are used to hatch the eggs and are not confined, both mother and chicks sometimes wander away and are lost unless closely watched.

In spite of their activity and the fact that they grow very rapidly, the little chicks, like young turkeys, are very sensitive to cold and dampness, and in northern climates it is safest to have them hatched not later than July, so that they may be well-grown before cold weather sets in. When allowed to range the old birds are very hardy, but if they are confined they also suffer from the same unfavorable weather conditions.

It can not be learned that there are any diseases peculiar to guinea fowl, and ordinarily they are very healthy. However, they are susceptible to at least some of the common poultry diseases. In the neighborhood of Washington, D. C., a considerable number of the guinea chicks raised by a poultry fancier of experience died, apparently from enterohepatitis or "blackhead." So far as can be learned no special studies of the diseases of guinea fowl have been made.

None of the American experiment stations have reported feeding tests or other work with guinea fowl, and few data on this topic have been found in the reports of foreign investigators. Indeed, so little

e guinea fowl been studied that no special rations have been pro-
ed for them. Some information has, however, been gained from
ıltry raisers and from other sources.

Vheat, corn, barley, oats, buckwheat, millet, and hemp seed are all
ommended as suitable grains for guinea hens, and it seems proba-
that, as is the case with other classes of poultry, a mixture would
ove more satisfactory than any single grain. In general, it may be
id that they seem to require very much the same rations as chick-
s of corresponding ages. According to one authority, they should
fed the same as turkeys. Corn and other grains, with green feed
d grit, are the staples, and, of course, pure water should always be
pplied. As usually kept, the guinea fowl eat with the chickens and
parently thrive on any of the usual mixed rations. For finishing for
rket a ration containing a large proportion of carbohydrates supplied
whole and ground grain is desirable, as is the case with other kinds
poultry. The fattening period should not be over one or two
eks, as overfat guinea fowl are not desirable. There are appar-
tly no reliable data regarding the amount of exercise which should
allowed during fattening.

The little guinea chicks should be fed almost immediately after
tching. They also need food oftener than ordinary chicks, because
ir crops are much smaller. Indeed, a fast of several hours is said
be fatal to the young birds. One writer on the subject suggests a
t of chopped eggs, oatmeal, canary seed, and onions for the first
o weeks. Another maintains that if bred in confinement guinea
vl should have rather more animal food than other poultry, because
ir natural food on the range contains such large quantities of
ects. Discussing guinea raising in Germany, Doctor Zürn states
t the larvæ of ants constitute the most satisfactory feed for newly-
tched guineas, and that for several weeks they may be fed as occa-
n offers with good results. The newly-hatched chicks, in his
inion, should be fed a mixture of bread crumbs and finely chopped
rd-boiled eggs, or cooked lean meat, especially beef heart. Cottage
ese (sour-milk curd) may also form a part of the mixture. When
ır or five days old, the chicks should be fed some green feed (lettuce,
ss, etc.), which should be finely chopped. Bread and milk is also
dily eaten, and after the chicks are a week old soaked millet seed is a
isfactory feed. After a time dry millet should be fed, and as the
cks grow older the ordinary ration of the full-grown birds can
dually replace these special feeds.

Some of the feeds mentioned above are not commonly given to
ultry in the United States, but the data quoted will serve to show
character of feeds which are considered sati[illegible]ly, an
undance of animal feed shortly after hatchi[illegible]

easily digested cereal, and a little later some green feed, then soft grain, and gradually the ordinary ration of full-grown poultry.

If they are allowed to wander, the adult birds may be trusted to find the bulk of their food; but of course they must be fed regularly in the poultry yard if they are expected to roost there. Guinea fowl are very fond of green feed and when allowed to range may do some damage to gardens unless watched, a fault, it is only fair to say, which is not confined to this class of poultry. So great is their appetite for insects that a few guinea fowl will make a noticeable difference in the number about a farm, and in thus helping to exterminate pests, if in no other way, they more than repay any trouble they may give by their hoarse cry and wandering habits. Guinea fowl, when allowed to range, also eat a very large number of weed seeds, and this, too, must be placed to their credit.

Experienced breeders consider that in beginning to raise guinea fowl it is better, if possible, to buy eggs for a common hen to hatch than to get adult birds. Their instinct for homing is as strong as that for ranging and they take very unwillingly to a change of dwelling. If adult birds are obtained, they should be kept in close confinement for some days. If guinea fowl are to be bred on a large scale, it would probably be wise to keep them in partial confinement, at least when young, and to encourage them in every way to roost and nest in the poultry yard. When they are to be kept in yards or runs, the latter must be completely inclosed with fine wire netting, for they can fly over the highest fence and the chicks can slip through 1-inch meshes.

Since the eggs are best hatched early in the season, it is advisable to collect all but enough for nest eggs up to the first of July and give them to common hens to hatch. The eggs laid during July and early August would doubtless bring a fair price in a fancy market in a region where guinea eggs are known and appreciated, while the guinea hens should be allowed to hatch and rear the later ones. As with other poultry the breeding stock for the following year should be selected in the autumn, and the remaining birds marketed as advantageously as possible.

In Europe guinea fowl are caponized and specially fed in the same way as common fowl, but so far as could be learned the practice is not followed in the United States.

MARKETING GUINEA FOWL.

From 5 to 8 months is the usual age for marketing guinea fowls. There is also quite a demand for very young chicks, weighing from half a pound to a pound, for broilers. In such young birds the flesh is very tender and resembles that of partridge or quail in flavor.

:n 5 to 10 months old, the flesh is said by some to closely resemble of pheasants, being especially "gamey" in flavor if the birds are wed to range. Others consider it dry and tasteless, and it seems ain that old birds are very apt to be decidedly tough. An adult l weighs from 3 to 4 pounds. Although guinea fowl belong to same order as common fowl and the flesh on the breast is lighter color than in other parts of the body, the meat throughout is darker n that of common fowl and has shorter fibers. Its color is said to ry with different varieties, that of white-feathered birds being quite ht in color. Some connoisseurs consider that the finest flavored eat is obtained from crosses between the pearl and the white strain.

On the Continent of Europe guinea fowl are considered very delicious ble birds and in England they are highly prized as substitutes for me, sometimes figuring on menus as "American pheasant."

They have always been eaten to a certain extent in the United States, pecially in the South, and have been much relished by those who re discriminating in their tastes, but until recently they have been mmonly said to be rather inferior to chickens, perhaps because of e darker color of the meat or because the majority of persons have ver had their attention called to their good points. The demand them in city markets has recently increased considerably, perhaps ite largely on account of the more stringent game laws now in force. eir flavor resembles in so many ways that of game birds that guinea vl furnish an excellent substitute for game. They seem as yet to little bought for private families except by the few who have rned to appreciate their excellent qualities; but some idea of their portance in club and restaurant menus may be gathered from the t that in a fashionable New York hotel 3,000 were used between the t of January and the middle of April, 1905.

The opinions regarding the palatability of guinea fowl have been firmed by a number of tests which were made by teachers of nestic science and others with the special purpose of securing data this bulletin. When well cooked the birds are attractive in appear:e and the flesh, particularly of young birds, is tender and of espelly fine flavor. The numerous ways in which they may be readily oked is an additional advantage in considering the possibilities of s class of poultry for the table.

The general method of preparing guinea fowl for market is much same as that employed for other poultry. In Europe they are nmonly fattened before killing, and the practice is desirable, although is little followed in this country. The birds fatten readily, and care st be taken not to market them in an overfat condition (see p. 13).

The best method of killing is to cut the [illegible] of the uth, as is done with chickens, and hang [illegible] the blood has ceased to flow. Especial care should be taken to chill the birds thoroughly before shipping, as the flesh decomposes readily if the animal heat is left in. Guinea fowl, so far as can be learned, are usually sold undrawn, and are commonly marketed unplucked or with the breast feathers removed (fig. 2), although sometimes they are wholly plucked. As they are usually classed with game, which is sold with the feathers on, and as their plumage is very handsome, they undoubtedly attract more attention and command a better price if unplucked. The feathers are easy to remove, and the undesirable practice of dipping the bird in hot water to loosen them is even less excusable than with most other kinds of poultry. Their plumage is

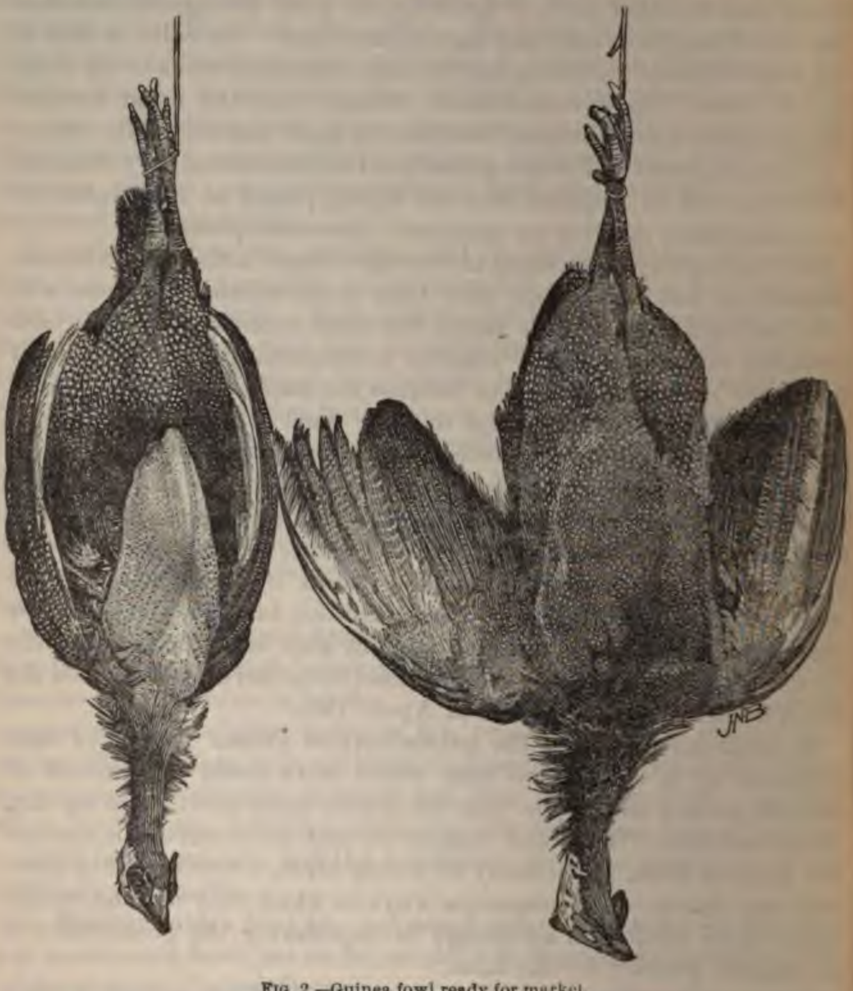

FIG. 2.—Guinea fowl ready for market.

ıick that plucked guinea fowl look much smaller than would be cted.

ıe marks of age in guinea fowl are similar to those in common . A flexible breast bone, soft, tender feet, and short sharp claws cate a young bird.

ı young birds, the outer wing feathers have pointed ends, and with ·r birds rounded ends. It is also claimed that age may be estimated he peculiar helmet on the head of some varieties of guineas. This es its appearance when the birds are 2 months old, and at the end year has attained its full size. The writers quoted state further until the birds are 15 to 18 months old the helmet is nearly black. ıen turns lead color, and becomes gradually lighter in color as the ls grow older.

should be remembered that the flesh is darker than that of ordi- chickens, and that a purplish-looking breast, which would suggest eness in the latter, is to be expected in guinea fowl.

he young birds for "broilers" begin to reach the market in the th late in the summer; the larger birds are killed throughout the ımn and early winter, and by means of cold storage the season is inued until spring. Since practically no breeders make a specialty uinea fowl for the market, the birds are supplied in small numbers oulterers who keep a few with their other kinds. The New York ers get their fresh guinea fowl largely from New Jersey. The lesale meat dealers in Chicago buy up the birds as they find them, and there, on farms, paying for them by the head rather than by ght, as with other varieties. The birds are put into cold storage l enough are collected for a shipment. Sometimes they are sold ur eastern markets, but often they are sent to England, where e is always a ready sale for them.

ny article is of value only in so far as a demand exists for it. etbreads in many country markets could recently and doubtless still be had almost for the asking. However, in city markets re there is a demand for them, the price is always high. Much same condition is found with squabs. A few pigeons have very monly been raised on many farms, yet the young birds have had ocal market value and have seldom appeared on the tables of those raised them. At the same time, squabs have been in demand in markets and have brought such good prices that squab raising has eloped into a special business. With guinea fowl the case is very ılar. In regions where they are grown in a limited way with other ltry, more as curiosities than for any special purpose, they are e generally disregarded as table birds, though here and there their its have been recognized and housekeepers [illegible] of the low prices consequent upon the limited demand. However, in towns where the total number of persons who are on the lookout for delicacies is large, guinea fowl have been appreciated, and they meet with a ready sale at good prices.

It is true of guinea fowl as of other classes of poultry that care and cleanliness in handling and dressing are of great importance, as is also an attractive manner of marketing, especially in supplying the demands of fancy trade. Many poultry raisers recognize the fact that well-dressed chickens, packed in suitable cases neatly lined with white paper, bring prices which could not be obtained for similar birds sent to market in a careless and unattractive way. With guinea fowl these points are of especial importance.

It is in supplying the trade which is willing to pay good prices for a fancy article that special profits must be sought. If the poultry raiser simply sells a few at a time in the usual way and for the same rates as other poultry, there will not be any great advantage. If, on the other hand, the producer supplies carefully fattened and dressed birds and can arrange to dispose of them to some dealer in high-grade goods, or to a consumer of large quantities—for instance a hotel or restaurant—it seems fair to say that there are opportunities for satisfactory profits, especially when it is remembered that the cost of raising guinea fowl is at least as low as with other classes of poultry and the prices which they bring in fancy markets are high.

It is obvious, therefore, that the conditions here are much the same as with many other special lines which are open to the farmer. It is not enough to produce a good article. It must be advantageously marketed as well. As an industry develops, market conditions change and it is not improbable that in time guinea fowls will become more staple articles and that prices will be more uniform than at present. Should such be the case, raising them for market would then present much the same problems as are now presented by the more staple lines of poultry production. At present a special market must be sought to secure the greatest profits.

PRICE OF GUINEA FOWL.

In Europe guinea fowl sell for good prices. It is said on good authority that a poultry raiser near Leipzig has for years made a specialty of these birds and has sold his product for an average price of 75 cents each. The same writer states that in Paris birds are sold in summer for 80 cents and in winter for 60 cents each, while the eggs bring twice as much as hens' eggs. In the United States the price of guinea fowl varies greatly with the season, the locality, and the individual market, but has in general advanced considerably during recent

ears. Whereas a pair formerly sold in New York at 50 to 90 cents,
hey now bring from 90 cents to $1.25 or more.

Guinea fowl are not separately included in the official market reports,
nd consequently it is difficult to obtain definite information regard-
ng their price. Private inquiry among reliable dealers in Boston,
ew York, Rochester, and Philadelphia indicates that in northeastern
ities the average retail price for a pair weighing 2 or 3 pounds each
probably about $1.25 in the autumn and early winter, while younger
irds earlier in the season and older birds later often bring $1.50 per
air or even more. In the South, where all poultry is cheaper, they
ost less. Information received from Montgomery, Ala., gives 30 to
5 cents each as an ordinary retail price. In Washington, D. C., a
ommon price in summer is 25 cents per pound. The wholesale Chi-
ago buyers, already referred to, pay on an average about 25 cents
er bird. From these rather desultory statements it would seem that
uinea fowl are sold to the consumer for prices not unlike those paid
or good young chickens in city markets. In the country, especially
n the Southern States, prices are usually lower than in the towns.

COOKING OF GUINEA FOWL.

Heretofore guinea fowl have been so little eaten in this country that
ost American cookbooks give no directions for cooking them. In
eneral, it may be said that they may be prepared for the table in
ractically the same way as other poultry of corresponding age and
ize. Very young birds are best broiled and should be trussed and
erved like chickens. The older birds are sometimes roasted, boiled,
ricasseed, or cooked with a little onion and bacon in a casserole. A
omely but excellent southern substitute for the latter method is
btained by covering the bottom of a skillet with sliced onions slightly
rowned, laying on it the guinea fowl nicely cut as for a fricassee,
utting thin strips of bacon over the meat, adding a little water, and
nally closing the skillet tightly, by means of paper tied over the top,
nd cooking in the oven until well done. Another favorite way is to
alf roast the birds and then finish the cooking by broiling. The gib-
ets may be used in gravy or otherwise like those of chickens. Boiled
ereals like samp or hominy are often served with guinea fowl in the
lace of potatoes.[a]

Guinea fowl and broilers may also be cooked in the same way as
ame birds, and appear quite commonly on hotel and restaurant menus
repared in such ways.

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[a] For recipes for cooking guinea fowl see Boston Cooking School Mag., 9 (1904–5),
p. 25, 421; 10 (1905–6), p. 85.

GUINEA HENS' EGGS.

Although the eggs of guinea fowl, like the flesh, have always been eaten more or less in this country, they have as yet had no special market value, and are, indeed, commonly regarded as inferior to hen's eggs, owing to their small size. European writers and epicures, on the other hand, consider them a great delicacy, with a rich flavor resembling that of the much-prized plovers' eggs. The delicate flavor is especially noticeable in the yolk, and either hard or soft boiled the eggs are very palatable. They are regarded by many as especially delicious when eaten cold with aspic jelly or other relish. Should they come to be appreciated in the United States their price would undoubtedly rise, and they might become a source of considerable profit, since the hens are excellent layers.

With Southern cooks the belief is quite generally held that guinea eggs are superior for cake making and similar purposes, since the white is thought to be lighter when whipped than that of hens' eggs. The eggs (fig. 3) are sometimes white, though more commonly light brown in color, usually speckled with a darker shade. They measure on an average 1.9 inches by 1.5 inches, are rather pointed at one end, and weigh about 1.4 ounces each, or 17 ounces to the dozen. On an average hens' eggs are 2.4 inches in length and 1.7 inches in diameter, and weigh about 2 ounces each, or 8 eggs to the pound, or 1.5 pounds to the dozen. The shells of guinea hens' eggs are so thick and often so dark that there is no simple way of testing the freshness by candling, and the buyer is forced to depend upon his dealer. If marketed in any considerable number, some of the egg-testing methods depending upon differences in the specific gravity of fresh and old eggs could doubtless be adapted to guinea eggs.

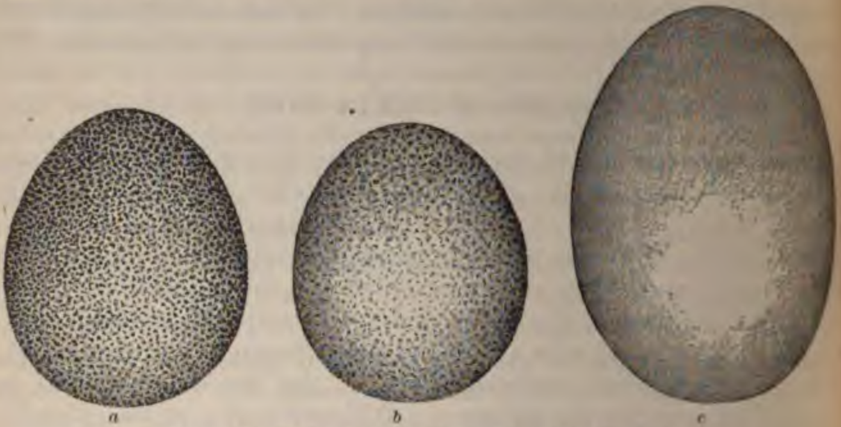

Fig. 3.—Guinea eggs (*a* and *b*) and a hen's egg (*c*) compared.

COMPOSITION AND FOOD VALUE OF THE FLESH AND EGGS OF GUINEA FOWL.

As far as can be learned, almost no studies have been made to ascertain the value of the flesh and eggs of guinea fowl as food. An investigation of the composition of guinea eggs and eggs of other domestic poultry was carried on at the Maine Experiment Station, and similar studies of the flesh were made at the Connecticut Storrs Experiment Station. The results of these analyses are given in the following table, in which similar analyses of other kinds of poultry and eggs are included for the sake of comparison:

Composition of guinea eggs and guinea flesh as compared with other eggs and poultry.[a]

	Refuse.	Water.	Protein.	Fat.	Ash.	Fuel value per pound.
FLESH.						
Guinea hen:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
As purchased	16.4	57.7	19.4	5.4	1.1	730
Edible portion		69.1	23.1	6.5	1.3	870
Meat, not including giblets		68.9	23.4	6.5	1.3	865
Giblets		69.9	20.8	7.1	1.3	855
Common fowl, young:						
As purchased	18.8	55.5	17.8	7.2	0.9	765
Edible portion		68.4	21.9	8.9	1.1	945
Meat, not including giblets		66.9	22.6	10.1	1.1	1,000
Dark meat		70.1	20.8	8.2	1.2	850
Light meat		70.3	21.9	7.4	1.1	835
Giblets		71.0	19.8	6.4	1.3	810
Common fowl, broiler:						
As purchased	29.1	51.2	15.5	3.3	0.8	540
Edible portion		69.7	20.7	8.3	1.1	890
Meat, not including giblets		69.2	21.1	8.8	1.1	880
Giblets		72.8	18.7	6.1	1.3	730
Turkey:						
As purchased	14.3	49.2	19.0	16.2	1.0	1,185
Edible portion		57.4	22.2	18.9	1.2	1,385
Dark meat		57.0	21.4	20.6	1.1	1,435
Light meat		63.9	25.7	9.4	1.3	1,065
Giblets		56.7	17.7	23.5	1.2	1,480
Duck:						
As purchased	15.9	51.4	15.4	16.0	1.1	1,085
Edible portion		61.1	18.3	19.0	1.3	1,290
Meat, not including breast or giblets		55.5	17.4	26.1	1.0	1,540
Breast		73.9	22.3	2.3	1.3	685
Giblets		73.2	17.9	5.0	1.8	720
Goose:						
As purchased	11.1	48.0	14.8	25.5	1.0	1,475
Edible portion		54.0	16.6	28.7	1.1	1,660
Meat, not including giblets		51.8	16.2	31.5	1.0	1,755
Giblets		70.0	20.1	8.2	1.7	910
EGGS.						
Guinea fowl:						
Whole egg as purchased	16.9	60.5	11.9	9.9	.8	640
Whole egg, edible portion		72.8	13.5	12.0	.9	755
White		86.6	11.6	.03	.8	215
Yolk		49.7	16.7	31.8	1.2	1,655
Hen:						
Whole egg as purchased	11.2	65.5	11.9	9.3	.9	635
Whole egg, edible portion		73.7	13.4	10.5	1.0	720
White		86.2	12.3	.2	.6	250
Yolk		49.5	15.7	33.3	1.1	1,705
Duck:						
Whole egg as purchased	13.7	60.8	12.1	12.5	.8	750
Whole egg, edible portion		70.5	13.8	14.5	1.0	860
White		87.0	11.1	.03	.8	210
Yolk		45.8	16.8	36.2	1.2	1,840

[a] The proportion of carbohydrates is so small in flesh and eggs that it is not usually estimated in food analyses.

Composition of guinea eggs and guinea flesh as compared with other eggs and poultry—Continued.

	Refuse.	Water.	Protein.	Fat.	Ash.	Fuel value per pound.
EGGS—continued.						
Turkey:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Calories.*
Whole egg as purchased	13.8	63.5	12.2	9.7	.8	635
Whole egg, edible portion		73.7	13.4	11.2	.9	720
White		86.7	11.5	.03	.8	215
Yolk		48.3	17.4	32.9	1.2	1,710
Plover:						
Whole egg as purchased[a]	9.6	67.3	9.7	10.6	.9	625
Whole egg, edible portion[a]		74.4	10.7	11.7	1.0	695

[a] European analyses.

In discussing these figures it should be remembered that the amount of refuse (bones, tendons, and skin of meat, shells of eggs, etc.) in a given kind of food lessens its value. Although water is needed by the body it is abundantly supplied in other ways, and that found in solid food materials is considered also to dilute them or to lessen their food value, pound for pound. Of the remaining ingredients, the protein, which makes up the gluten of wheat and is the main constituent of the lean of meat, the white of eggs, etc., is especially important, as it alone can build up the tissues of the body. The fats, carbohydrates, and any excess of protein are, in a way not yet completely understood, burned in the body to yield energy for its activities and heat to keep it warm. The mineral matters, or ash, are needed in the bones and in other parts of the body.

The flesh of guinea fowl appears to have a lower proportion of refuse than that of chicken and a trifle more than that of turkey, duck, or goose. This factor, however, varies considerably with the age of the birds, the younger ones having a skeleton of relatively greater weight than older birds, and it is therefore unwise to draw very decided inference from the scanty data available. The same is in a measure true of the edible portion of poultry flesh, but it may be said in general that the flesh of guinea hen contains a relatively higher proportion of protein and a correspondingly lower amount of fat than that of chicken, turkey, etc., but the differences do not seem great enough to be very important.

So far as can be learned no studies have been made of the digestibility of guinea flesh. It seems probable that in this respect it would be much like chicken and turkey—that is, it would rank with the easily and quite thoroughly digested foods.

Whether any kind of food is truly economical or not depends partly on its cost and partly on the amount of actual digestible material which it supplies. The larger the proportion of refuse, water, and undigestible nutrients it contains the smaller will be the amount of useful erial supplied to the body for a certain sum of money. Judging the best available data guinea fowl and chicken, at moderate prices, ld about as much actual nourishment as medium cuts of beef, mut- , and pork and are fairly economical; but at fancy prices they are ectly comparable with such expensive meats as fillet of beef and ench lamb chops. Of course, if they are eaten on the farm where ey are raised, and especially if they have found most of their food, ey are evidently an economical kind of meat. On the other hand, must not be supposed that as sold in city markets their price is cessarily prohibitive. Families that can afford porterhouse steak d turkey can well afford guinea fowl at ordinary prices, and will d that they give a very pleasant variety in the meat list.

On an average hens' eggs contain 12 per cent shell, 30 per cent yolk, d 58 per cent white, and guinea eggs 14 per cent shell, 32 per cent lk, and 54 per cent white. In other words, the shell is thicker and e yolk makes up a larger proportion of the total egg contents than the case with hens' eggs.

The eggs of guinea fowl appear not to differ very greatly in compo- ion from ordinary hens' eggs. The refuse consists entirely of the ell with the membrane lining it, and makes up a slightly larger pro- rtion of the guinea egg than of the hen's egg. In respect to pro- in, the two kinds are practically alike, nor is there a noticeable fference in the amount of ash contained in each. The guinea hen's gs contain a slightly larger proportion of fat and have a correspond- gly higher fuel value per pound, but even this difference is not fficient to be of importance. Unless further study should show fferences in digestibility it is not probable that the two kinds of gs will be found to differ appreciably in nutritive value. As regards vor epicures consider that the advantage is with the guinea eggs.

It is true of guinea eggs as of the eggs of other domestic poultry at the yolk and white differ greatly in composition. The white ntains somewhat less protein and almost twice as much water as the lk, but is practically free from fat and has the lower ash content. e greater part of the egg fat is found in the yolk and about two- irds of the total ash. In the case of hens' eggs lecithin, a fat-like dy containing phosphorus, is a characteristic constituent of the egg lk, and this is doubtless also the case with the guinea eggs.

CONCLUSION.

From this discussion it seems that guinea fowl might well be bred the United States more extensively than is yet the case, either along th other poultry or in larger numbers by themselves. The varieties ve been improved in recent years and there is [illegible] the improvement will continue and breeding them will become an increasingly important branch of the poultry industry. The birds do well with comparatively little care and require comparatively little food in addition to what they will gather if allowed to range. In spite of the half-wild habits which they retain when allowed to range, they may be trained to more domestic ways and may be readily fed and fattened like other poultry. Even when very young they are exceptionally hardy and free from disease. Although noisy and quarrelsome, these habits have their use, as they are commonly thought to give warning of hawks or other intruders in the poultry yard. Guineas eat such large numbers of insects that they are often useful in helping to destroy these pests. They also eat many wild seeds and in this way are of value.

There is already a fair demand for guinea fowl, especially in New York and other cities in the eastern United States. If, as seems probable, the demand for guinea fowl as a substitute for game or other poultry continues to increase, the birds ought to become a source of considerable profit to poultry raisers. Very young birds for broilers bring good prices early in the season in city markets, while the older ones are easily sold throughout the autumn and winter. They may be prepared for the table like ordinary fowl or like game birds.

They have very much the same food value as chicken and are as economical when bought at about the same price per pound. At moderate prices they furnish the body with about as much nourishment for a given sum as medium cuts of beef and mutton, and at higher prices correspond in value with the more expensive cuts and such poultry as turkey, green goose, etc. While they can hardly be recommended for families that have to make every penny count, they might well be more extensively eaten by the moderately well-to-do, and would furnish a most acceptable variety. Guinea eggs also are considered very choice eating, and, while they are much like hens' eggs in food value, they have a very delicate flavor and make a welcome change when obtainable. It will, without doubt, be of benefit to both breeders and buyers if, as seems probable, guinea fowl become more appreciated as table birds in this country.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 235.

CEMENT MORTAR AND CONCRETE:

PREPARATION AND USE FOR FARM PURPOSES.

BY

PHILIP L. WORMELEY, Jr.,
TESTING ENGINEER, OFFICE OF PUBLIC ROADS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of Public Roads,
Washington, D. C., October 14, 1905.

Sir: I have the honor to transmit herewith the manuscript of a paper by Mr. Philip L. Wormeley, jr., which gives elementary directions for the preparation and use of cement mortar and concrete. The paper is designed to give information to those unfamiliar with the subject, and I believe will be particularly useful to farmers. I respectfully recommend that it be published as a Farmers' Bulletin.

Respectfully,

Logan Waller Page,
Director.

Hon. James Wilson,
Secretary of Agriculture.

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CEMENT MORTAR AND CONCRETE: PREPARATION AND USE FOR FARM PURPOSES.

INTRODUCTION.

The many letters received and referred to the Office of Public Roads with reference to the use of cement and the adaptability of concrete for various farm purposes have made it seem advisable to issue a short bulletin on the subject, in which a proper method of mixing concrete is described, together with a few of the many uses for which concrete is well adapted. No attempt has been made to give a technical discussion of the subject, the sole object being to treat in an elementary way those points in concrete construction which are of particular interest to the farmer.

In the appendix will be found the results of tests made to determine the strength of reinforced concrete fence posts, together with tests showing the effect of retempering Portland cement mortar, and a diagram (fig. 14) illustrating the variation in strength of cement mortar produced by different proportions of clay in the sand.

CEMENT.

The term " hydraulic cement " is applied to one of the most useful materials of engineering construction and one which in recent years has become widely extended in its field of application. Hydraulic cement possesses the property of hardening, or setting, under water, in which respect it differs from lime, which does not harden except in the presence of air. Thus it is evident that in all places where air is excluded, such as foundations, thick walls, etc., cement mortar should be used instead of lime.

Only two classes of cement will be discussed here—Portland and natural. The difference between these is due partly to the method of manufacture and partly to the condition and relative proportions of the materials employed, which are, generally speaking, limestone and clay. In the manufacture of Portland cement the separate materials are mixed in such proportions as have been found by experience to give the best results. The mixing is done by grinding the materials together in mills, after which the mixture is burned at a very high temperature in kilns, and the resulting clinker ground to an impalpable powder is known as Portland cement. In the case of natural cement the materials used have been already mixed by nature in approximately the correct proportions, being found in the form of a rock which is generally classed as a clay limestone, or a limey deposit technically called calcareous clay. This material is burned at a much lower temperature than Portland cement. When the manufacturer has each ingredient absolutely under control and can adjust the proportions to suit all conditions, it is reasonable to expect that a better and more uniform product will result than when the materials are found already mixed. Portland cement is far more extensively employed than natural cement on account of its superior strength, although the latter is frequently used in cases where great strength is of little importance. The superior strength and durability of cement as compared with lime, together with the low price at which it may now be procured, have caused the former to replace the latter in engineering construction to a great extent.

STORING CEMENT.

In storing cement care must be exercised to insure its being kept dry. When no house or shed is available for the purpose, a rough platform may be erected clear of the ground, on which the cement may be placed and so covered as to exclude water. When properly protected, it often improves with age. Cement is shipped in barrels or bags, the size and weight of which usually are as follows:

Bulk and weight of cement in ordinary barrels and bags.

Kind of cement.	Per barrel.		Per bag.	
	Quantity.	Weight (net).	Quantity.	Weight (net).
	Cu. ft.	*Pounds.*	*Cu. ft.*	*Pounds.*
Portland	3½	380	⅞	95
Natural[a]	3¾	300	¾	75

[a] Western natural cement usually weighs about 265 pounds per barrel net.

CEMENT MORTAR.

Cement mortar is an intimate mixture of cement and sand mixed with sufficient water to produce a plastic mass. The amount of water will vary according to the proportion and condition of the sand, and had best be determined independently in each case. Sand is used both for the sake of economy and to avoid cracks due to shrinkage of cement in setting. Where great strength is required, there should be at least sufficient cement to fill the voids or air spaces in the sand, and a slight excess is preferable in order to compensate for any un-distribution in the mixing. Common proportions for Portland cement mortar are 3 parts sand to 1 of cement, and for natural cement mortar, 2 parts sand to 1 of cement. Unless otherwise stated, materials for mortar or concrete are considered to be proportioned by volume, the cement being lightly shaken in the measure used.

A "lean" mortar is one having only a small proportion of cement, while a "rich" mixture is one with a large proportion of cement. "Neat" cement is pure cement, or that with no admixture of sand. The term "aggregate" is used to designate the coarse materials entering into concrete—usually gravel or crushed rock. The proportion in which the three elements enter into the mixture is usually expressed by three figures separated by dashes—as, for instance, 1–3–5—meaning 1 part cement, 3 parts sand, and 5 parts aggregate.

In the great majority of cases cement mortar is subjected only to compression, and for this reason it would seem natural, in testing it, to determine its compressive strength. The tensile strength of cement mortar, however, is usually determined, and from this its resistance to compression may be assumed to be from eight to twelve times greater. A direct determination of the compressive strength is a less simple operation, for which reason the tensile test is in most cases accepted as indicating the strength of the cement.

MIXING.

In mixing cement mortar it is best to use a platform of convenient size or a shallow box. First, deposit the requisite amount of sand in a uniform layer, and on top of this spread the cement. These should be mixed dry with shovels or hoes, until the whole mass exhibits a uniform color. Next, form a crater of the dry mixture, and into this pour nearly the entire quantity of water required for the batch. Work the dry material from the outside toward the center, until all the water is taken up, then turn rapidly with shovels, adding water at the same time by sprinkling until the desired consistency is attained. It is frequently specified that the mortar shall be turned a certain number of times, but a better practice for securing a uniform mixture is to watch the operation and judge by the eye when the mixing has been carried far enough. In brick masonry the mistake is frequently made of mixing the mortar very wet and relying upon the bricks to absorb the excess of water. It is better, however, to wet the bricks thoroughly and use a stiff mortar.

GROUT.

The term "grout" is applied to mortar mixed with an excess of water, which gives it about the consistency of cream. This material is often used to fill the voids in stone masonry, and in brick work the inner portions of walls are frequently laid dry and grouted. The practice in either case is to be condemned, except where the conditions are unusual, as cement used in this way will never develop its full strength.

LIME AND CEMENT MORTAR.

L. C. Sabin[a] finds that in a Portland cement mortar containing three parts sand to one of cement, 10 per cent of the cement may be replaced by lime in the form of paste without diminishing the strength of the mortar, and at the same time rendering it more plastic. In the case of natural cement mortar, lime may be added to the extent of 20 to 25 per cent of the cement with good results. The increased plasticity due to the addition of lime much facilitates the operation of laying bricks, and has caused lime and cement mortar to become largely used.

CEMENT MORTAR FOR PLASTERING.

In plastering with cement, a few precautions must be observed to insure good and permanent results. The surface to receive the plaster should be rough, perfectly clean, and well saturated with water. A mortar very rich in cement is rather a drawback than otherwise on account of shrinkage cracks, which frequently appear. The mortar, consisting of two or three parts sand to one of cement, should be mixed with as little water as possible and well worked to produce plasticity. It is essential that the plaster be kept moist until it has thoroughly hardened.

MATERIALS FOR MAKING CONCRETE.

SAND.

In securing sand for mixing mortar or concrete, if it is possible to select from several varieties, that sand should be chosen which is composed of sharp, angular grains, varying in size from coarse to fine. Such sand is, however, not always obtainable, nor is it essential for good work. Any coarse-grained sand which is fairly clean will answer the purpose. If gravel, sticks, or leaves be present they should be removed by screening. The voids in sand vary from 30 to 40 per cent, according to the variation in size of grains. A sand with different-sized grains is to be preferred, because less cement is required to fill the voids. By mixing coarse and fine sand it is possible to reduce the voids considerably.

It is customary to use the terms "river sand," "sea sand," or "pit sand," according to the source of supply. River sand as a rule has rounded grains, but unless it contains an excess of clay or other imrities, it is suitable for general purposes. When river sand is of a ht color and fine-grained it answers well for plastering.

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[a] Sabin, L. C., Cement and Concrete. 1905.

Sea sand may contain the salts found in the ocean. The tendency of ese salts to attract moisture makes it advisable to wash sea sand fore using it for plastering or other work which is to be kept per- ctly dry.

Pit sand for the most part will be found to have sharp, angular rains, which make it excellent for mortar or concrete work. Where lay occurs in pockets it is necessary either to remove it, or else see hat it is thoroughly mixed with the sand. The presence of clay in xcess frequently makes it necessary to wash pit sand before it is uitable for use.

The results of tests made in this laboratory would indicate that the resence of clay, even in considerable amounts, is a decided benefit to lean " mortars, whereas it does not appreciably affect the strength of rich mixture.[a]

GRAVEL.

It is important that gravel for use in concrete should be clean, in rder that the cement may properly adhere to it, and form a strong nd compact mass. As with sand, it is well to have the pieces vary in ize, thereby reducing the voids to be filled with mortar. The voids in eneral range from 35 to 40 per cent.

CRUSHED STONE.

The best stone for concrete work consists of angular pieces, varying in size and having a clean, rough surface. Some form of strong and durable rock is to be preferred, such as limestone, trap, or granite. The total output of the crusher should be used below a maximum size, depending upon the nature of the work in hand. All material under ne-eighth inch will act as so much sand and should be considered as such in proportioning the mixture. (See p. 10.) Precautions must be taken to insure a uniform distribution of the smaller pieces of stone, otherwise the concrete will have an excess of fine material in some parts and a deficiency in others.

Less than 8 per cent of clay will probably not seriously impair the strength of the concrete, provided the stones are not coated with it, and may even prove a benefit in the case of lean mixtures. The voids in crushed stone depend upon the shape and variation in size of pieces, rarely falling below 40 per cent, unless much fine material is present, and in some cases reaching 50 per cent. A mixture of stone and gravel in equal parts makes an excellent aggregate for concrete.

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[a] See Appendix, p. 32.

STONE VERSUS GRAVEL.

It would appear from tests that crushed stone makes a somewhat stronger concrete than gravel, but the latter is very extensively used with uniformly good results. This superiority of stone over gravel for concrete work is attributed to the fact that the angular pieces of stone interlock more thoroughly than do the rounded pebbles, and offer a rougher surface to the cement. A point in favor of gravel concrete is that it requires less tamping to produce a compact mass than in the case of crushed stone. Then, too, the proportion of voids in stone being usually greater than in gravel, a proportionately greater amount of mortar is required to fill the voids, which means a slight increase in the cost of concrete.

CINDERS.

Cinder concrete is frequently used in connection with expanded metal and other forms of reinforcement for floor construction, and for this purpose it is well adapted on account of its light weight. Its porosity makes it a poor conductor of heat and permits the driving of nails. Only hard and thoroughly burned cinders should be used, and the concrete must be mixed quite soft so as to require but little tamping and to avoid crushing the cinders. Cinder concrete is much weaker, both in tension and compression, than stone or gravel concrete, and for this reason admits only of light reinforcement.

CONCRETE.

GENERAL DISCUSSION.

Cement concrete is the product resulting from an intimate mixture of cement mortar with an aggregate of crushed stone, gravel, or similar material. The aggregate is crushed or screened to the proper size as determined from the character of the work. In foundation work, stone or gravel 3 inches in size may be used to advantage, whereas in the case of molded articles of small sectional area, such as fence posts, hollow building blocks, etc., it is best to use only such material as will pass a one-half inch screen. An ideal concrete, from the standpoint of strength and economy, would be that in which all voids in the aggregate were completely filled with sand, and all voids in the sand completely filled with cement, without any excess. Under these conditions there would be a thoroughly compact mass and no waste of materials.

It is a simple matter to determine the voids in sand and also in the aggregate, but in mixing concrete the proportions vary a great deal, depending in each case upon the nature of the work and the strength desired. For example, in the construction of beams and floor panels, where maximum strength with minimum weight is desired, a rich concrete is used, whereas in massive foundation work, in which bulk or weight is the controlling factor, economy would point to a lean mixture. When good stone or gravel is used, the strength of the concrete depends upon the strength of the mortar employed in the mixing and the proportion of mortar to aggregate. For a given mortar the concrete will be strongest when only enough mortar is used to fill the voids in the aggregate, less strength being obtained by using either a greater or less proportion. In practice it is usual to add a slight excess of mortar over that required to fill the voids in the aggregate.

It is more accurate to measure cement by weight, unless the unit employed be the barrel or sack, because when taken from the original package and measured in bulk there is a chance of error due to the amount of shaking the cement receives. As it is less convenient, however, to weigh the cement it is more common to measure it by volume, but for the reason stated this should be done with care.

PROPORTIONING MATERIALS.

For an accurate determination of the best and most economical proportions where maximum strength is required, it is well to proceed in the following way: First, proportion the cement and sand so that the cement paste will be 10 per cent in excess of the voids in sand; next, determine the voids in the aggregate and allow sufficient mortar to fill all voids, with an excess of 10 per cent.

To determine roughly the voids in gravel or crushed stone, prepare a water-tight box of convenient size and fill with the material to be tested; shake well and smooth off even with the top. Into this pour water until it rises flush with the surface. The volume of water added, divided by the volume of the box, measured in the same units, represents the proportion of voids. The proportion of voids in sand may be more accurately determined by subtracting the weight of a cubic foot of packed sand from 165, the weight of a cubic foot of quartz, and dividing the difference by 165.[a]

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[a] The following will serve as an example of proportioning materials: Assume voids in packed sand to measure 38 per cent and voids in packed stone to measure 48 per cent. Cement paste required per cubic foot of sand $=0.38+\frac{1}{10}\times0.38=0.42$ cubic foot, approximately. By trial 1 cubic foot of loose cement, lightly shaken, makes 0.85 cubic foot of cement paste, and requires $\frac{0.85}{0.42}$, or 2 cubic feet of sand, approximately, producing an amount of mortar equal to $0.85+2(1-0.38)=2.09$ cubic feet. Mortar required per cubic foot of stone $=0.48+\frac{1}{10}\times0.48=0.528$ cubic foot. Therefore 2.09 cubic feet mortar will require $\frac{2.09}{0.528}=4$ cubic feet of stone, approximately. The proportions are therefore 1 part cement, 2 parts sand, 4 parts stone. Although such a determination is usually considered unnecessary in practical work, it may be of sufficient interest to justify giving it.

For general use the following mixtures are recommended.

1 cement, 2 sand, 4 aggregate, for very strong and impervious work.
1 cement, 2½ sand, 5 aggregate, for ordinary work requiring moderate strength.
1 cement, 3 sand, 6 aggregate, for work where strength is of minor importance

AGGREGATE CONTAINING FINE MATERIAL.

In the case of gravel containing sand, or crushed stone from which the small particles have not been removed by screening, the amount of such sand or fine stone should be determined and due allowance made for it in proportioning the mortar.

When mixing an aggregate containing small particles with mortar, the same conditions obtain as if these particles had been screened from the aggregate and added to the sand used in making the mortar, and in reality we have a mortar containing a larger proportion of sand than was present before the aggregate was incorporated. It is evident, then, that in such cases the quality or richness of the mortar should depend upon the proportion of fine material in the aggregate.

For example, suppose that 1 cubic foot of gravel contains 0.1 cubic foot of sand, and that the voids in gravel with sand screened out measure 40 per cent. For general purposes this would suggest a 1–2–5 mixture, but since each cubic foot contains 0.1 cubic foot sand, 5 cubic feet of gravel will contain 0.5 cubic foot sand, and the proportions should be changed to 1 part cement, 1½ parts sand, 5 parts gravel.

MECHANICAL MIXERS.

It has been demonstrated that concrete can be mixed by machinery as well, if not better, than by hand. Moreover, if large quantities of concrete are required, a mechanical mixer introduces marked economy in the cost of construction. None of the various forms of mechanical mixers will be described here, since concrete in small quantities, as would be used on the farm, is more economically mixed by hand.

MIXING BY HAND.

In mixing concrete by hand a platform is constructed as near the work as is practicable, the sand and aggregate being dumped in piles at the side. If the work is to be continuous, this platform should be of sufficient size to accommodate two batches, so that one batch can be mixed as the other is being deposited. The cement must be kept under cover and well protected from moisture. A convenient way of measuring the materials is by means of bottomless boxes or frames made to hold the exact quantities needed for a batch.

A very common and satisfactory method of mixing concrete is as follows: First measure the sand and cement required for a batch and mix these into mortar as described on page 5. Spread out this mortar in a thin layer and on top of it spread the aggregate, which has been previously measured and well wetted. The mixing is done by turning with shovels three or more times, as may be found necessary to produce a thoroughly uniform mixture, water being added if necessary to give the proper consistency. The mixers, two or four in number, according to the size of the batch, face each other and shovel to right and left, forming two piles, after which the material is turned back into a pile at the center. By giving the shovel a slight twist, the material is scattered in leaving it and the efficiency of the mixing is much increased.

CONSISTENCY OF CONCRETE.

A dry mixture, from which water can be brought to the surface only by vigorous tamping, is probably the strongest, but for the sake of economy, and to insure a dense concrete well filling the molds, a moderately soft mixture is recommended for ordinary purposes. Where the pieces to be molded are thin, and where small reinforcing metal rods are placed close together or near the surface, a rather wet mixture may be necessary to insure the molds being well filled.

USE OF QUICK-SETTING CEMENT.

In the manufacture of such articles as pipe, fence posts, and hollow blocks, a rather large proportion of quick-setting cement is sometimes used, the object being to reduce the weight and consequent freight charges by means of a strong mixture, as well as to make the concrete impervious to water. The use of a quick-setting cement permits the molds to be removed sooner than would be possible with a slow-setting cement, thus reducing the number of molds necessary for a given output. Quick-setting cements are not recommended for such purposes, however, as they are usually inferior to those which set slowly.

COLORING CEMENT WORK.

In coloring cement work the best results are obtained by the use of mineral pigments. The coloring matter, in proportions depending upon the desired shade, should be thoroughly mixed with the dry cement before making the mortar. By preparing small specimens of the mortar and noting the color after drying, the proper proportions may be determined.

For gray or black, use lampblack.
For yellow or buff, use yellow ocher.
For brown, use umber.
For red, use venetian red.
For blue, use ultramarine.

DEPOSITING CONCRETE.

Concrete should be deposited in layers of from 4 to 8 inches and thoroughly tamped before it begins to harden. The tamping required will depend upon the consistency of the mixture. If mixed very dry it must be vigorously rammed to produce a dense mass, but as the proportion of water increases less tamping will be found necessary. Concrete should not be dumped in place from a height of more than 4 feet, unless it is again mixed at the bottom. A wooden incline may be used for greater heights. Rammers for ordinary concrete work should weigh from 20 to 30 pounds and have a face not exceeding 6 inches square. A smaller face than this is often desirable, but a larger one will be less effective in consolidating the mass. In cramped situations special forms must be employed to suit the particular conditions. When a thickness of more than one layer is required, as in foundation work, two or more layers may be worked at the same time, each layer slightly in advance of the one next above it and all being allowed to set together. At the end of a day there is usually left a layer partially completed which must be finished the next day. This layer should not be beveled off, but the last batch of concrete should be tamped behind a vertical board forming a step.

To avoid introducing a plane of weakness where fresh concrete is deposited upon that which has already set, certain precautions have to be observed. The surface of the old work should be clean and wet before fresh material is put on, a thin coating of neat cement grout being sometimes employed to insure a good bond. The surface of concrete to receive an additional layer must not be finished off smoothly, but should offer a rough surface to bond with the next layer. This may be done by roughing the surface while soft with pick or shovel, or the concrete may be so rammed as to present a rough and uneven surface. Wooden blocks or scantling are sometimes embedded several inches in the work and removed before the concrete hardens, thus forming holes or grooves to be filled by the next layer.

RETEMPERING.

As stated before, it is important that concrete be tamped in place before it begins to harden, and for this reason it is proper to mix only so much at a time as is required for immediate use. The retempering of concrete which has begun to set is a point over which there is much controversy. From tests made in this laboratory[a] it would appear that such concrete suffers but little loss of strength if thoroughly mixed with sufficient water to restore normal consistency.

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[a] See Appendix, p. 31.

The time required for concrete to set depends upon the character of the cement, upon the amount and temperature of the water used in mixing, and upon the temperature of the air. Concrete mixed dry sets more quickly than if mixed wet, and the time required for setting decreases as the temperature of the water rises. Warm air also hastens the setting.

CONCRETE EXPOSED TO SEA-WATER.

Portland cement concrete is well adapted for work exposed to sea-water, but when used for this purpose it should be mixed with fresh water. The concrete must be practically impervious, at least on the surface, and to accomplish this the materials should be carefully proportioned and thoroughly mixed. It is also of great importance that the concrete be well compacted by tamping, particularly on exposed surfaces.

CONCRETE WORK IN FREEZING WEATHER.

Although it is advisable under ordinary circumstances to discontinue cement work in freezing weather, Portland cement may be used without serious difficulty by taking a few simple precautions. As little water as possible should be used in mixing, to hasten the setting of the cement. To prevent freezing, hot water is frequently used in mixing mortar or concrete, and with the same object in view salt is added in amounts depending upon the degree of cold. A common practice is to add 1 pound of salt to 18 gallons of water, with the addition of 1 ounce of salt for each degree below 32° F. Either of the above methods will give good results, but it should be remembered that the addition of salt often produces efflorescence. It seems to be a fairly well-established fact that concrete deposited in freezing weather will ultimately develop full strength, showing no injury due to the low temperature.

RUBBLE CONCRETE.

In massive concrete work considerable economy may often be introduced by the use of large stones in the body of the work, but only in heavy foundations, retaining walls, and similar structures should this form of construction be permitted. In placing these large stones in the work the greatest care must be exercised to insure each being well bedded, and the concrete must be thoroughly tamped around them. Each stone should be at least 4 inches from its neighbor and an equal distance from the face of the work.

TO FACE CONCRETE.

A coating of mortar one-half to 1 inch in thickness is frequently placed next the form to prevent the stone or gravel from showing and to give a smooth and impervious surface. If in preparing this mortar finely crushed stone is used instead of sand, the work will more nearly resemble natural stone. A common method employed in facing concrete is to provide a piece of thin sheet metal of convenient length and about 8 or 10 inches wide. To this pieces of angle iron are riveted, so that when placed next to the mold a narrow space is formed in which the cement mortar is placed after the concrete has been deposited behind it (fig. 1). The metal plate is then withdrawn and the concrete well tamped. The concrete and facing mortar must be put in at the same time so that they will set together. If the concrete is fairly rich. a smooth surface can usually be produced without a facing of mortar by working a spade up and down between the concrete and inner face of the mold, thus forcing the larger pieces of the aggregate back from the surface.

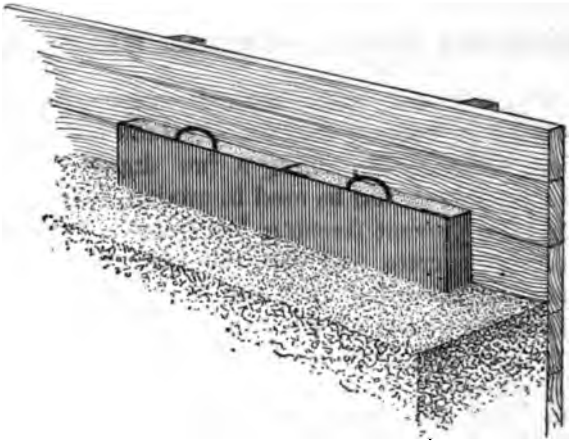


FIG. 1.—Sheet-metal plate used in facing concrete.

WOOD FOR FORMS.

Lumber used in making forms for concrete should be dressed on one side and both edges. The expansion and distortion of the wood due to the absorption of water from the concrete frequently make it difficult to produce an even surface on the work, and unless the forms are accurately fitted together more or less water will find its way out through the cracks, carrying some of the cement with it. A method sometimes adopted to minimize the effect of expansion is to bevel one edge of each board, allowing this edge to crush against the square edge of the adjacent board when expansion takes place. In the case of a wooden core or inside mold, expansion must always be taken into consideration, for if neglected it may cause cracks or complete rupture of the concrete. Sharp edges in concrete are easily chipped and should be avoided by placing triangular strips in the corners of molds. To prevent cement from sticking to the forms they may be given a coating of soft soap or be lined with paper. This greatly facilitates their removal and enables them to be used again with but little scraping. A wire brush answers best for cleaning the forms.

CONCRETE SIDEWALKS.

A useful and comparatively simple application of concrete is in the construction of sidewalks, for which purpose it has been used with marked success for a number of years.

EXCAVATION AND PREPARATION OF SUBGRADE.

The ground is excavated to subgrade and well consolidated by ramming to prepare it for the subfoundation of stone, gravel, or cinders. The depth of excavation will depend upon the climate and nature of the ground, being deeper in localities where heavy frosts occur or where the ground is soft than in climates where there are no frosts. In the former case the excavation should be carried to a depth of 12 inches, whereas in the latter from 4 to 6 inches will be sufficient. No roots of trees should be left above subgrade.

THE SUBFOUNDATION.

The subfoundation consists of a layer of loose material, such as broken stone, gravel, or cinders, spread over the subgrade and well tamped to secure a firm base for the main foundation of concrete which is placed on top. It is most important that the subfoundation be well drained to prevent the accumulation of water, which, upon freezing, would lift and crack the walk. For this purpose it is well to provide drain tile at suitable points to carry off any water which may collect under the concrete. An average thickness for subfoundation is 4 to 6 inches, although in warm climates, if the ground is firm and well drained, the subfoundation may be only 2 to 3 inches thick or omitted altogether.

THE FOUNDATION.

The foundation consists of a layer of concrete deposited on the subfoundation and carrying a surface layer or wearing coat of cement mortar. If the ground is firm and the subfoundation well rammed in place and properly drained, great strength will not be required of the concrete, which may, in such cases, be mixed in about the proportions 1–3–6, and a depth of only 3 to 4 inches will be required. Portland cement should be used and stone or gravel under 1 inch in size, the concrete being mixed of medium consistency, so that moisture will show on the surface without excessive tamping.

THE TOP DRESSING OR WEARING SURFACE.

To give a neat appearance to the finished walk, a top dressing of cement mortar is spread over the concrete, well worked in, and brought to a perfectly smooth surface with straightedge and float. This mortar should be mixed in the proportion 1 part cement to 2 parts sand, sharp coarse sand or screenings below one-fourth inch of some hard, tough rock being used. The practice of making the concrete of natural cement and the wearing surface of Portland is not to be commended, owing to a tendency for the two to separate.

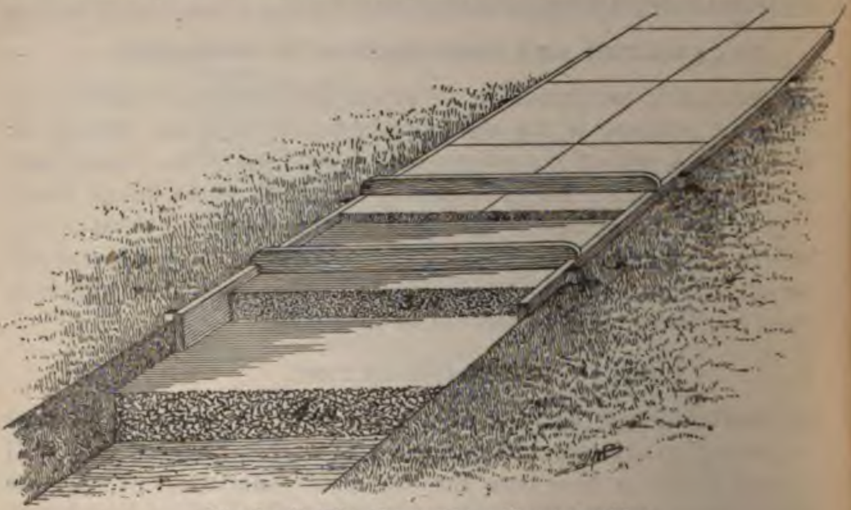


FIG. 2.—Details of concrete walk construction.

DETAILS OF CONSTRUCTION.

A cord stretched between stakes will serve as a guide in excavating, after which the bottom of the trench is well consolidated by ramming, any loose material below subgrade being replaced by sand or gravel. The material to form the subgrade is then spread over the bottom of the trench to the desired thickness and thoroughly compacted. Next, stakes are driven along the sides of the walk, spaced 4 to 6 feet apart, and their tops made even with the finished surface of the walk, which should have a transverse slope of one-fourth inch to the foot for drainage. Wooden strips at least 1½ inches thick and of suitable depth are nailed to these stakes to serve as a mold for the concrete. By carefully adjusting these strips to the exact height of the stakes they may be used as guides for the straightedge in leveling off the concrete and wearing surface. The subfoundation is well sprinkled to receive the concrete, which is deposited in the usual manner, well tamped behind a board set vertically across the trench, and leveled off with a straightedge as shown in fig. 2, leaving one-half to 1 inch for the wearing surface. Three-eighths inch sand joints are provided at intervals of 6 to 8 feet to prevent expansion cracks, or, in case of settlement, to confine the cracks to these joints. This is done either by depositing the concrete in sections, or by dividing it into such sections with a spade when soft and filling the joints with sand. The location of each joint is marked on the wooden frame for future reference.

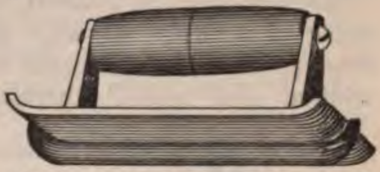


FIG. 3.—Jointer used in dividing walk into sections.

Care must be exercised to prevent sand or any other material from being dropped on the concrete, and thus preventing a proper union with the wearing surface. No section should be left partially completed to be finished with the next batch or left until the following day. Any concrete left after the completion of a section should be mixed with the next batch.

It is of the utmost importance to follow up closely the concrete work with the top dressing in order that the two may set together. This top dressing should be worked well over the concrete with a trowel, and leveled with a straightedge (fig. 2) to secure an even surface. Upon the thoroughness of this operation often depends the success or failure of the walk, since a good bond between the wearing surface and concrete base is absolutely essential. The mortar should be mixed rather stiff. As soon as the film of water begins to leave the surface, a wooden float is used, followed up by a plasterer's trowel, the operation being similar to that of plastering a wall. The floating, though necessary to give a smooth surface, will, if continued too long, bring a thin layer of neat cement to the surface and probably cause the walk to crack.

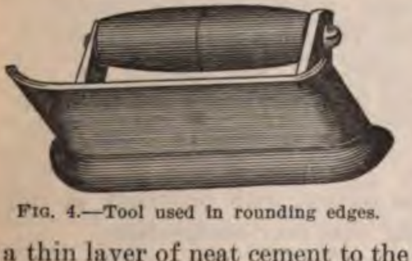


FIG. 4.—Tool used in rounding edges.

The surface is now divided into sections by cutting entirely through, exactly over the joints in the concrete. This is done with a trowel guided by a straightedge, after which the edges are rounded off with a special tool called a jointer, having a thin shallow tongue (fig. 3). These sections may be subdivided in any manner desired for the sake of appearance.

A special tool called an edger (fig. 4) is run around the outside of the walk next to the mold, giving it a neat rounded edge. A toothed roller (fig. 5) having small projections on its face is frequently used to produce slight indentations on the surface, adding somewhat to the appearance of the walk. The completed work must be protected from the sun and kept moist by sprinkling for several days. In freezing weather the same precautions should be taken as in other classes of concrete work.

CONCRETE BASEMENT FLOORS.

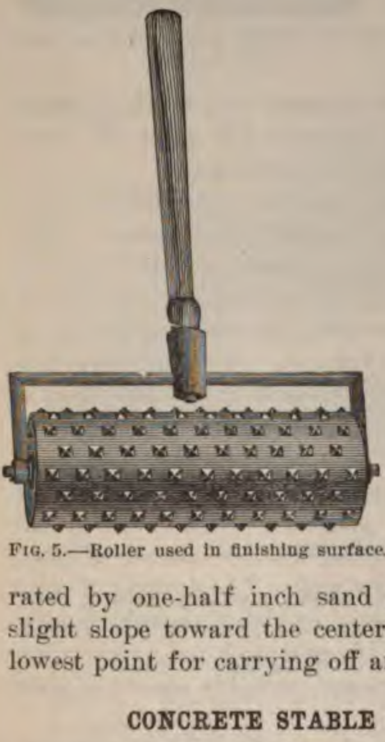


FIG. 5.—Roller used in finishing surface.

Basement floors in dwelling houses as a rule require only a moderate degree of strength, although in cases of very wet basements, where water pressure from beneath has to be resisted, greater strength is required than would otherwise be necessary. The subfoundation should be well drained, sometimes requiring the use of tile for carrying off the water. The rules given for constructing concrete sidewalks apply equally well to basement floors. The thickness of the concrete foundation is usually from 3 to 5 inches, according to strength desired, and for average work a 1-3-6 mixture is sufficiently rich. Expansion joints are frequently omitted, since the temperature variation is less than in outside work, but since this omission not infrequently gives rise to unsightly cracks, their use is recommended in all cases. It will usually be sufficient to divide a room of moderate size into four equal sections, separated by one-half inch sand joints. The floor should be given a slight slope toward the center or one corner, with provision at the lowest point for carrying off any water that may accumulate.

CONCRETE STABLE FLOORS AND DRIVEWAYS.

Concrete stable floors and driveways are constructed in the same general way as basement floors and sidewalks, but with a thicker foundation, on account of the greater strength required. The foundation may well be 6 inches thick, with a 1-inch wearing surface. An objection sometimes raised against concrete driveways is that they become slippery when wet; but this fault is in a great measure overcome by dividing the wearing surface into small squares about 4 inches on the side, by means of triangular grooves three-eighths of an inch deep. This gives a very neat appearance and furnishes a good foothold for horses.

CONCRETE STEPS.

Concrete may be advantageously used in the construction of steps, particularly in damp places, such as areaways and cellars of houses; and in the open, where the ground is terraced, concrete steps and walks can be made exceedingly attractive. Where the ground is firm it may be cut away as nearly as possible in the form of steps, with each step left 2 or 3 inches below its finished level. The steps are formed, beginning at the top, by depositing the concrete behind vertical boards so placed as to give the necessary thickness to the risers and projecting high enough to serve as a guide in leveling off the tread. Such steps may be reinforced where greater strength is desired or where there is danger of cracking, due to settlement of the ground.

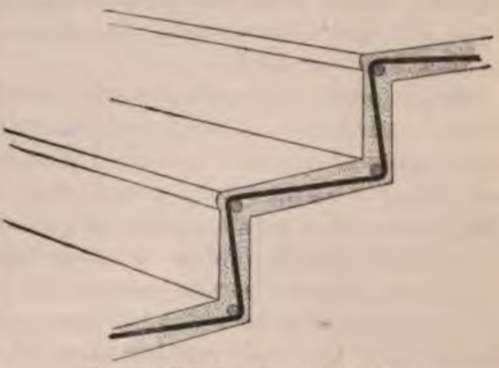


FIG. 6.—Reinforced concrete steps.

Where the nature of the ground will not admit of its being cut away in the form of steps, the risers are molded between two vertical forms. The front one may be a smooth board, but the other should be a piece of thin sheet metal, which is more easily removed after the earth has been tamped in behind it. A simple method of reinforcing steps is to place a half-inch steel rod in each corner, and thread these with quarter-inch rods bent to the shape of the steps, as shown in fig. 6, the latter being placed about 2 feet apart. For this class of work a rich Portland cement concrete is recommended, with the use of stone or gravel under one-half inch in size. Steps may be given a half-inch wearing surface of cement mortar mixed in the proportion 1 part cement to 2 parts sand. This system, as well as many others, is well adapted for stairways in houses.

REINFORCED CONCRETE FENCE POSTS.

COMPARISON OF DIFFERENT POST MATERIALS.

There is a constantly increasing demand for some form of fence post which is not subject to decay. The life of wooden posts is very limited, and the scarcity of suitable timber in many localities has made it imperative to find a substitute. A fence post, to prove thoroughly satisfactory, must fulfill three conditions: (1) It must be obtainable at a reasonable cost; (2) it must possess sufficient strength to meet the demands of general farm use; (3) it must not be subject to decay and must be able to withstand successfully the effects of water, frost, and fire. Although iron posts of various designs are frequently used for ornamental purposes, their adoption for general farm use is prohibited by their excessive cost. Then, too, iron posts exposed to the weather are subject to corrosion, to prevent which necessitates repainting from time to time, and this item will entail considerable expense in cases where a large number of posts are to be used.

At the present time the material which seems most nearly to meet these requirements is reinforced concrete. The idea of constructing fence posts of concrete reinforced with iron or steel is by no means a new one, but on the contrary such posts have been experimented with for years, and a great number of patents have been issued covering many of the possible forms of reinforcement. It is frequently stated that a reinforced concrete post can be made and put in the ground for the same price as a wooden post. Of course this will depend in any locality upon the relative value of wood and the various materials which go to make up the concrete post, but in the great majority of cases, wood will prove the cheaper material in regard to first cost. On the other hand, a concrete post will last indefinitely, its strength increasing with age, whereas the wooden post must be replaced at short intervals, probably making it more expensive in the long run.

In regard to strength, it must be borne in mind that it is not practicable to make concrete fence posts as strong as wooden posts of the same size; but since wooden posts, as a rule, are many times stronger than is necessary, this difference in strength should not condemn the use of reinforced concrete for this purpose. Moreover, strength in many cases is of little importance, the fence being used only as a dividing line, and in such cases small concrete posts provide ample strength and present a very uniform and neat appearance. In any case, to enable concrete posts to withstand the loads they are called upon to carry, sufficient strength may be secured by means of reinforcement, and where great strength is required this may be obtained by using a larger post with a greater proportion of metal and well braced, as is usual in such cases. In point of durability, concrete is unsurpassed by any material of construction. It offers a perfect protection to the metal reinforcement and is not itself affected by exposure, so that a post constructed of concrete reinforced with steel will last indefinitely and require no attention in the way of repairs.

REINFORCEMENT.

No form of wooden reinforcement, either on the surface or within the post, can be recommended. If on the surface, the wood will soon decay, and if a wooden core is used it will in all probability swell by the absorption of moisture and crack the post. The use of galvanized wire is sometimes advocated, but if the post is properly constructed and a good concrete used, this precaution against rust will be unnecessary, since it has been fully demonstrated by repeated tests that concrete protects steel perfectly against rust. If plain, smooth wire or rods are used for reinforcement they should be bent over at the ends or looped to prevent slipping in the concrete. Twisted fence wire may usually be obtained at a reasonable cost and is very well suited for this purpose. Barbed wire has been proposed and is sometimes used, although the barbs make it extremely difficult to handle. For the sake of economy the smallest amount of metal consistent with the desired strength must be used, and this requirement makes it necessary to place the reinforcement near the surface, where its strength is utilized to greatest advantage, with only enough concrete on the outside to form a protective covering. A reinforcing member in each corner of the post is probably the most efficient arrangement.

CONCRETE FOR FENCE POSTS.

The concrete should be mixed with Portland cement in about the proportion 1–2½–5, broken stone or gravel under one-half inch being used. In cases where the aggregate contains pieces smaller than one-fourth inch, less sand may be used, and in some cases it may be omitted altogether. A mixture of medium consistency is recommended on the ground that it fills the molds better, and with less tamping than if mixed quite dry.

MOLDS FOR FENCE POSTS.

Economy points to the use of a tapering post, which, fortunately, offers no difficulties in the way of molding. All things considered wooden molds will be found most suitable. They can be easily and quickly made in any desired size and form. Posts may be molded either in a vertical or horizontal position, the latter being the simpler and better method. If molded vertically a wet mixture is necessary, requiring a longer time to set, with the consequent delay in removing the molds. Fig. 7 shows a simple mold, which has been used with satisfactory results in this laboratory. This mold has a capacity of four posts, but larger molds could easily be made on the same principle. It consists of two end pieces (*a*) carrying lugs (*b*) between which are inserted strips (*c*). The several parts are held together with hooks and eyes, as shown in fig. 7. To prevent any bulging of the side strips they are braced, as illustrated. Dressed lumber at least 1 inch thick, and preferably 1½ inches, should be used. In fig. 7 the post measures 6 by 6 inches at the bottom, 6 by 3 inches at the top, and 7 feet in length, having two parallel sides.

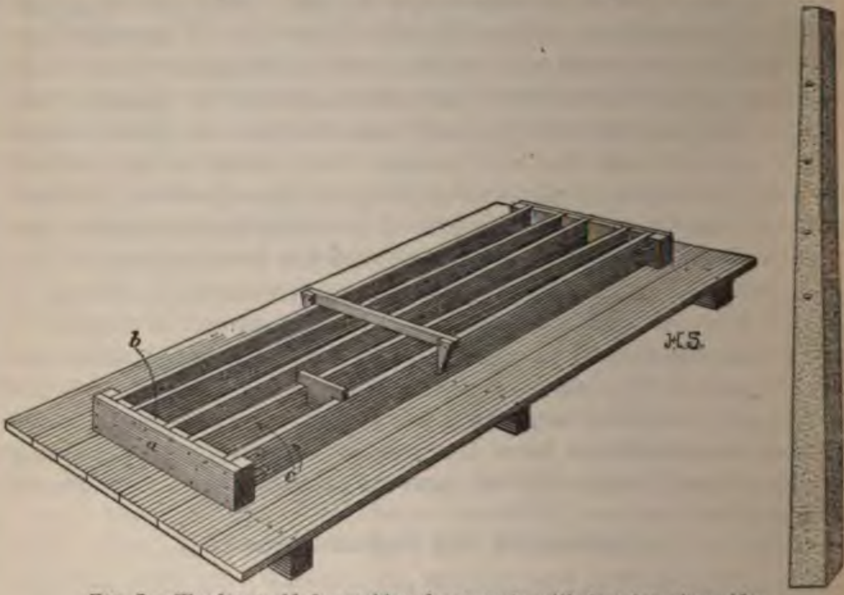


FIG. 7.—Wooden mold for making fence posts with two tapering sides.

If it is desired to have the posts square at both ends the mold must be arranged as in fig. 8. This latter form of post is not as strong as the former, but requires less concrete in its construction. Great care in tamping is necessary to insure the corners of the mold being well filled, and if this detail is not carefully watched, the metal, being exposed in places, will be subject to rust.

ATTACHING FENCE WIRES TO POSTS.

Various devices have been suggested for attaching fence wires to the posts, the object of each being to secure a simple and permanent fastener or one admitting of easy renewal at any time. Probably nothing will answer the purpose better than a long staple or bent wire well embedded in the concrete, being twisted or bent at the end to prevent extraction. Galvanized metal must be used for fasteners since they are not protected by the concrete. A piece of small flexible wire, about 2 inches in length, threading the staple and twisted several times with a pair of pliers, holds the line wire in position (fig. 9).

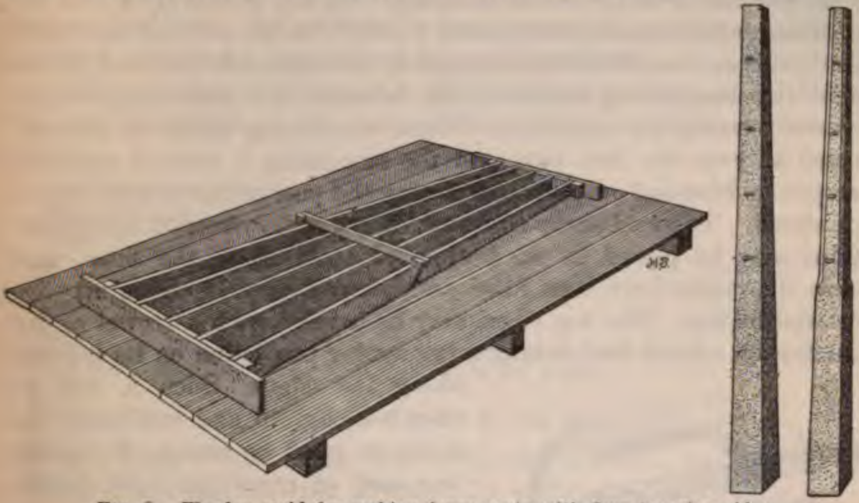


FIG. 8.—Wooden mold for making fence posts with four tapering sides.

MOLDING AND CURING POSTS.

For the proper method of mixing concrete see page 10. It is recommended that only so much concrete be mixed at one time as can be used before it begins to harden; but if an unavoidable delay prevents the posts being molded until after the concrete has begun to set, it is thought that a thorough regaging with sufficient water to restore normal consistency will prevent any appreciable loss of strength, though the concrete may have been standing one or two hours. In using a mold similar to those illustrated in figs. 7 and 8, it is necessary to provide a perfectly smooth and even platform of a size depending upon the number of posts to be molded. A cement floor if accessible may be used to advantage. The molds when in place are given a thin coating of soft soap, the platform or cement

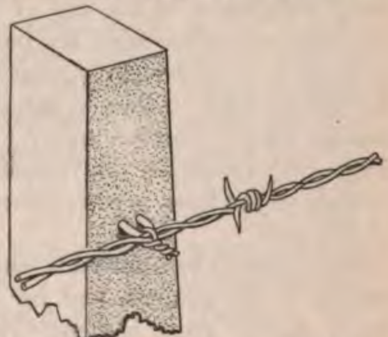


FIG. 9.—Detail showing method of attaching wire to post.

floor serving as bottom of mold being treated in the same way. About $1\frac{1}{2}$ inches of concrete is spread evenly over the bottom and carefully tamped, so as to reduce it to a thickness of about 1 inch. A piece of board cut as in fig. 7 will be found useful in leveling off the concrete to the desired thickness before tamping. On top of this layer two reinforcing members are placed about 1 inch from the sides of the mold. The molds are then filled and tamped in thin layers to the level of the other two reinforcing members, the fasteners for fence wires being inserted during the operation. These reinforcing members are adjusted as were the first two, and the remaining 1 inch of concrete tamped and leveled off, thus completing the post so far as molding is concerned. To avoid sharp edges which are easily chipped triangular strips may be placed in the bottom of mold along the sides, and when the molds have been filled and tamped, similar strips may be inserted on top. The top edges may be beveled with a trowel or by running an edging tool having a triangular projection on its bottom along the edges. Such a tool is shown in fig. 10 and can easily be made of wood or metal. It is not necessary to carry the bevel below the ground line.

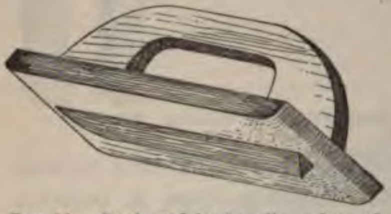


FIG. 10.—Tool used for beveling edges of posts.

The ends and sides of the mold may be removed after twenty-four hours, but the posts should not be handled for at least one week, during which time they must be well sprinkled several times daily and protected from sun and wind. The intermediate strips may be carefully withdrawn at the end of two or three days, but it is better to leave them in place until the posts are moved. Although a post may be hard and apparently strong when one week old, it will not attain its full strength in that length of time and must be handled with the utmost care to prevent injury. Carelessness in handling green posts frequently results in the formation of fine cracks, which, though unnoticed at the time, give evidence of their presence later in the failure of the post.

Posts should be allowed to cure for at least sixty days before being placed in the ground, and for this purpose it is recommended that when moved from the molding platform they be placed upon a smooth bed of moist sand and protected from the sun until thoroughly cured. During this period they should receive a thorough drenching at least once a day.

The life of the molds will depend upon the care with which they are handled. A coating of mineral oil or shellac may be used instead soap to prevent the cement from sticking to the forms. As soon the molds are removed they should be cleaned with a wire brush ore being used again.

The cost of reinforced concrete fence posts depends in each case n the cost of labor and materials, and must necessarily vary in ferent localities. An estimate in any particular case can be made follows: One cubic yard of concrete will make 20 posts measuring nches by 6 inches at bottom, 6 inches by 3 inches at top, and 7 feet g, and if mixed in the proportions 1–2½–5, requires approxitely—

1.16 barrels of cement, at $2	$2.32
0.44 cubic yard of sand, at 75 cents	.33
0.88 cubic yard of gravel, at 75 cents	.66
Materials for 1 cubic yard concrete	3.31
Concrete for one post	.17
28 feet of 0.16-inch steel wire, at 3 cents per pound	.06
Total cost of concrete and metal for one post	.23

To this must be added the cost of mixing concrete, molding and ndling posts, and the cost of molds, an addition which should not any case exceed 7 cents, making a total of 30 cents per post.

CONCRETE BUILDING BLOCKS.

Concrete building blocks, or cement blocks, as they are frequently led, are more extensively used now than ever before. These blocks molded hollow primarily to reduce their cost, but this hollow conuction serves other useful purposes at the same time. The fundantal principles governing ordinary concrete work, so far as prortioning and mixing materials is concerned, apply equally well to manufacture of building blocks, and it should be borne in mind at strength and durability can not be attained by the use of any maine unless the cement, sand, and aggregate are of good quality, operly proportioned, and well mixed. The aggregate for blocks of dinary size should be crushed stone or gravel not larger than onelf inch. One of the chief causes of complaint against the concrete ilding block is its porosity, but this defect is in a great measure due the fact that in an endeavor to economize, too little cement is freently used. It is not unusual to give the blocks a facing of cement rtar consisting of about 2 parts sand to 1 of cement, while the body the block is composed of a concrete of sufficient strength, though not pervious. This outside layer of mortar adds practically nothing to strength of the block, and is used simply to give a uniform sure and to render the face of the wall more nearly impervious to ter.

It would not be practicable as a rule to attempt the manufacture of concrete blocks without one of the many forms of molding machines designed for the purpose, nor would it be economical to purchase such a machine unless a sufficient number of blocks were required to justify such an outlay. Blocks in almost any desired shape and size, with either plain or ornamental faces, may be obtained on the market, and in the great majority of cases it is best to buy them from some reliable firm. Among the advantages claimed for hollow concrete block construction may be mentioned the following:

(1) Hollow block construction introduces a saving of material over brick or stone masonry.

(2) The cost of laying concrete blocks is less than for brickwork. This is due to the fact that the blocks, being larger, require a much smaller number of joints and less mortar, and, being hollow, are of less weight than solid brickwork.

(3) A wall constructed of good concrete blocks is as strong or stronger than a brick wall of equal thickness.

(4) Concrete blocks, being easily molded to any desired form, will prove to be a far more economical building material than stone, which has to be dressed to shape.

(5) Experience has proved concrete to be a most excellent fire-resisting material.

(6) Concrete blocks, being hollow, tend to prevent sudden changes of temperature within a house, making it cool in summer and easily heated in winter.

(7) The hollow spaces provide an easy means for running pipes and electric wires. These spaces may also be used wholly or in part for heating and ventilating flues.

APPENDIX.

TESTS OF CONCRETE FENCE POSTS.

In the summer of 1904 a number of reinforced concrete fence posts ere made for experimental purposes, with a view to determining eir adaptability for general use. These posts were made both with nd without reinforcement, and tested at the age of 90 days. The einforcement, ranging from 0.27 per cent to 1.13 per cent, consisted f four round steel rods, one in each corner of post about 1 inch from he surface, the posts having a uniform cross-section of 6 by 6 inches. The posts were molded in a horizontal position, as this was found by rial to be more satisfactory than molding them vertically.

The concrete was mixed moderately soft, crushed stone between 1 inch and one-fourth inch and gravel under three-fourths inch being used as aggregate. River sand, fairly clean and sharp, was mployed with Portland cement. The posts were tested as beams pported at both ends and loaded at the center, with spans varying from 4 feet to 5 feet 6 inches. An attempt was made to prevent slip-ing by providing the reinforcing rods with collars and set screws t the ends, but in every case, with but two exceptions, the rods slipped nder a comparatively light load, thus showing the necessity for some rm of mechanical bond. As would be expected, those posts which ere not reinforced possessed very little strength.

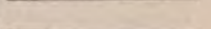
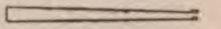
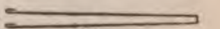
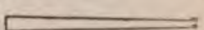
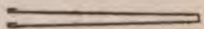
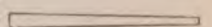
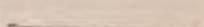
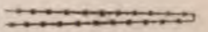
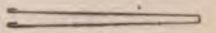
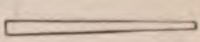
A series of tests were made with sheet-iron reinforcement, in the rm of round and square pipes, embedded in the posts, but these sts, though developing considerable strength, proved less econom- al than those reinforced with plain rods, and at the same time were ss simple in construction. The results of these tests, as recorded in able I, do not properly represent the strength of similar posts in hich some form of mechanical bond is provided to develop the full rength of the reinforcement.

Table 1.—*Showing results of preliminary tests of reinforced concrete fence posts.*

No.	Kind of reinforcement.	Per cent of reinforcement.	Mixture.	Material.	Span.	Load at first crack.	Maximum load.	Equivalent load on 4-foot cantilever at first crack.	Equivalent maximum load on 4-foot cantilever.
					Ft. in.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1	No reinforcement.	....	1-3-5	Stone ..	4 0	1,435	1,435	359	359
2	.....do	....	1-3-5	.....do ...	4 0	670	670	168	168
20	.....do	....	1-3-7	Gravel .	4 6	700	700	196	196
25	.....do	....	1-3-5	....do ...	4 6	320	320	90	90
26	.....do	....	1-2-5	....do ...	4 0	1,100	1,100	275	275
30	.....do	....	1-2-5	....do ...	4 0	1,000	1,000	250	250
4	Plain steel rods..	0.27	1-3-5	Stone ...	4 0	1,580	1,850	395	462
17	.....do	.27	1-3-5	....do ...	4 0	1,135	1,945	284	486
21	.....do	.27	1-3-5	....do ...	4 6	920	1,690	258	473
24	.....do	.27	1-3-5	....do ...	4 6	940	1,660	263	465
28	.....do	.27	1-3-5	....do ...	4 6	800	1,720	224	482
35	.....do	.27	1-2-5	Gravel .	4 0	1,100	1,550	275	388
36	.....do	.27	1-2-5	....do ...	4 6	900	1,460	252	409
39	.....do	.27	1-2-5	....do ...	4 0	1,340	1,640	335	410
40	.....do	.27	1-2-5	....do ...	5 6	700	1,120	258	381
42	.....do	.27	1-2-5	....do ...	4 6	1,100	1,290	308	361
44	.....do	.27	1-2-5	....do ...	5 6	....	1,080	....	367
3	.....do	.52	1-3-5	Stone ..	4 0	1,800	2,530	450	632
7	.....do	.52	1-3-5	....do ...	4 6	1,600	2,155	448	605
13	.....do	.52	1-3-5	....do ...	4 0	1,640	2,500	410	625
15	.....do	.52	1-3-5	....do ...	4 0	1,960	2,400	490	600
27	.....do	.52	1-3-5	....do ...	4 0	1,680	2,220	420	555
45	.....do	.52	1-2-5	Gravel .	5 6	920	1,800	313	612
46	.....do	.52	1-2-5	....do ...	4 0	900	2,740	225	685
47	.....do	.52	1-2-5	....do ...	4 6	1,000	2,450	280	686
50	.....do	.52	1-2-5	....do ...	4 0	1,200	3,125	300	781
5	.....do	.81	1-3-5	Stone ..	4 0	2,640	4,800	660	1,200
10	.....do	.81	1-3-5	....do ...	4 0	1,480	4,100	370	1,025
12	.....do	.81	1-3-5	....do ...	4 6	1,860	4,100	521	1,148
14	.....do	.81	1-3-5	....do ...	4 6	1,800	3,915	504	1,096
19	.....do	.81	1-3-5	....do ...	4 0	1,800	4,160	450	1,040
22	.....do	.81	1-3-5	....do ...	4 6	1,900	2,900	532	812
34	.....do	.81	1-2-5	Gravel .	4 6	1,750	4,100	490	1,148
37	.....do	.81	1-2-5	....do ...	4 0	1,500	3,545	375	886
43	.....do	.81	1-2-5	....do ...	4 0	1,700	4,200	425	1,050
48	.....do	.81	1-2-5	....do ...	4 6	1,240	3,575	347	1,001
6	.....do	.95	1-3-5	Stone ..	4 0	1,980	5,150	495	1,288
11	.....do	.95	1-3-5	....do ...	4 6	2,380	4,300	666	1,204
18	.....do	.95	1-3-5	....do ...	4 6	1,800	4,240	504	1,187
49	.....do	.95	1-2-5	Gravel .	5 6	900	2,600	306	884
51	.....do	.95	1-2-5	....do ...	4 6	1,380	3,160	386	885
52	.....do	.95	1-2-5	....do ...	4 6	1,200	3,345	336	937
53	.....do	.95	1-2-5	....do ...	4 0	1,340	3,840	335	960
54	.....do	.95	1-2-5	....do ...	5 6	980	2,600	333	884
8	.....do	1.13	1-3-5	Stone ..	4 6	2,220	3,820	622	1,070
9	.....do	1.13	1-3-5	....do ...	4 0	2,560	5,080	640	1,270
16	.....do	1.13	1-3-5	....do ...	4 6	2,000	3,100	560	868
23	.....do	1.13	1-3-5	....do ...	4 0	1,800	4,900	450	1,225
29	.....do	1.13	1-3-5	....do ...	4 0	2,400	4,460	600	1,115
32	.....do	1.13	1-2-5	Gravel .	4 6	1,500	2,900	420	812
33	.....do	1.13	1-2-5	....do ...	4 0	1,400	2,320	350	580
38	.....do	1.13	1-2-5	....do ...	4 6	1,500	3,270	420	916
41	.....do	1.13	1-2-5	....do ...	4 6	1,250	4,300	350	1,204
55	Pipe 5 inches diameter, $\frac{1}{40}$-inch thick.	1.10	1-2-5	....do ...	4 6	1,800	4,000	504	1,120
56	.....do	1.10	1-2-5	....do ...	4 6	1,720	4,000	482	1,120
57	.....do	1.10	1-2-5	....do ...	4 6	....	4,660	....	1,305
58	☐ 5 by 5 inches, $\frac{1}{40}$-inch thick.	1.39	1-2-5	....do ...	4 6	2,400	6,320	672	1,770
59	.....do	1.39	1-2-5	....do ...	4 6	2,100	5,880	588	1,646
60	.....do	1.39	1-2-5	....do ...	4 6	2,200	6,040	616	1,691
61	× 5 by 5 inches, $\frac{1}{40}$-inch thick.	.98	1-2-5	Stone ..	4 6	1,100	2,450	308	686
62	.....do	.98	1-3-5	....do ...	4 6	860	2,660	241	745
63	.....do	.98	1-3-5	....do ...	4 6	1,800	2,400	504	672

In order to obtain more data on the subject, this investigation has been supplemented by a second series of tests, the results of which rm the subject-matter for the sections on concrete fence posts and e expressed numerically in Table II.

TABLE II.—*Showing the strength of reinforced concrete fence posts.*

o.	Kind of reinforcement.	Total sectional area of reinforcement.	Load at first crack.	Maximum load.	Equivalent load on 4-foot cantilever at first crack.	Equivalent maximum load on 4-foot cantilever.	Form of reinforcement.
		Sq. in.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	
1	Drawn steel rods	0.08	800	1,120	218	306	
2	do	.08	820	1,145	224	313	
3	do	.08	640	1,080	175	295	
4	do	.08	795	1,040	217	284	
37	do	.08	940	1,170	257	319	
38	do	.08	740	1,075	202	293	
9	do	.19	1,140	1,280	311	349	
10	do	.19	1,170	1,885	319	515	
11	do	.19	1,020	1,950	278	532	
39	do	.19	760	1,945	207	531	
40	do	.19	820	1,925	224	526	
13	Twisted fence wire	.06	825	935	225	255	
15	do	.06	755	905	206	247	
16	do	.06	800	940	218	257	
17	do	.06	815	935	222	255	
18	do	.06	770	980	210	268	
19	do	.06	780	975	213	266	
21	do	.13	1,550	1,920	423	524	
22	do	.13	1,275	1,670	348	456	
23	do	.13	1,200	1,830	328	500	
24	do	.13	1,500	1,955	410	534	
25	Barbed wire	.06	980	980	268	268	
26	do	.06	820	820	224	224	
27	do	.06	590	740	161	202	
28	do	.06	745	745	203	203	
29	do	.06	590	590	161	161	
30	do	.06	550	640	150	175	
31	do	.06	560	635	153	173	
32	do	.06	480	530	131	145	
33	do	.13	680	1,040	186	284	
34	do	.13	840	1,010	229	276	
35	do	.13	1,280	1,515	349	414	
36	do	.13	800	1,375	218	375	
6	Drawn steel rods	.08	Tested by impact				
7	do	.19	do				
8	do	.19	do				
14	Twisted fence wire	.06	do				
20	do	.06	do				

In these tests it was decided to make the posts tapering in order to onomize material and reduce their weight. For the concrete, Portnd cement, river sand, and gravel were used in the proportion 2½–5, measured by volume, the gravel being screened below onelf inch. Sufficient water was used in mixing to produce a plastic ass, requiring only a moderate degree of tamping to bring water the surface. The posts were molded, as described on page 23, pt under wet burlap for four weeks, and tested at the end of sixty ys. The reinforcing members were placed in the corners of the sts about 1 inch from the surface, being looped and bent, as indited in Table II. These posts were not designed with a view to deloping the ultimate compressive strength of the concrete, but where eater strength is necessary it may be obtained at small expense by creasing the percentage of reinforcement. It is important that a fairly rich concrete should be used in all cases to enable the pc stand exposure and to prevent chipping.

In these tests, as in those previously described, the object w determine what transverse load, applied at a point 4 feet abov ground line, would be sufficient to crack the post, as well as the mum load which could be sustained. Accordingly the posts supported and loaded, as illustrated in figure 11, from whi is evident that the reaction at *R* repr the equivalent transverse load at the e a 4-foot cantilever, corresponding t applied load *W* at *A*, which is suppos be the ground line, near which point ure occurred in every case except pos 9, which sheared along the neutral All of these posts measured 6 by 6 inches at the bottom and 6 inches at the top, except Nos. 29, 30, 31, 32, 33, and 34, which 6 by 6 inches at the bottom and 3 by 3 inches at the top. It w noticed that the saving in concrete introduced in the constructi these posts is accompanied by a marked decrease in strength as pared with the other posts similarly reinforced. It would als pear that the twisted wire has a slight advantage over the b wire as a reinforcing material, particularly when two wires are used in each corner of the post.

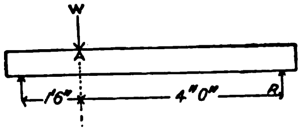


FIG. 11.—Method of testing posts under static loads.

As stated on page 20, it is impracticable to make a reinforced concrete fence post as strong as a wooden post of the same size, and this is more especially true if the post has to withstand the force of a sudden blow or impact. In order to study the behavior of these posts under impact, a number of them were braced, as illustrated in figure 12, and subjected to the blows of a 50-pound bag of gravel, suspended from above by a 9-foot rope. The first blow was delivered by deflecting the bag so give it a vertical drop of 1 foot, and for each successive blow the was increased 1 foot. None of the posts showed any sign of fa under the first blow. Posts Nos. 14 and 20 cracked under the s blow, and failed under the third. Post No. 6 cracked under th ond blow, which crack opened under the third blow, causi momentary deflection of 5 inches. Posts Nos. 7 and 8 each deve

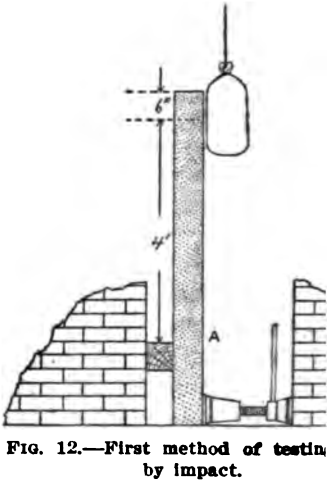


FIG. 12.—First method of testin by impact.

crack under the second blow, but showed no further signs of weak-ss after the fifth blow, other than a slight opening of the initial ack. In each case the only crack developed was at point *A*. Posts 7, and 8, which cracked but did not fail under the impact test, were rther tested, as indicated in figure 13, by raising the small end and lowing them to drop from successive heights at 1, 2, 3, and 4 feet. nder this test a number of cracks developed, but in no case did the inforcement fail.

Although it might appear from these results that posts as here scribed have hardly enough rength to recommend them for neral use, it should be remembered at in many cases fence posts are ot subjected to impact, and it may rove more economical to replace om time to time those which fail in is way than to use wooden posts, hich, being subject to decay, must all be replaced sooner or later.

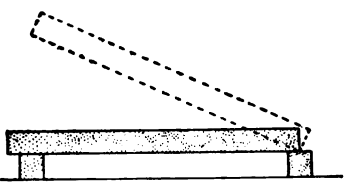


FIG. 13.—Second method of testing posts by impact.

RETEMPERING.

Table III illustrates the effect of retempering Portland cement ortar. The mortars used consisted of Portland cement and crushed uartzite between one and two millimeters in size, mixed in different roportions. In each case, after the initial or final set had taken lace, sufficient water was added in retempering to restore normal nsistency. The briquettes were tested at the age of four months.

TABLE III.—*Effect of retempering on cement mortars.*

Treatment of mortar.	Tensile strength, in pounds per square inch.			
	Neat cement.[a]	1 part cement, 1 part sand.[b]	1 part cement, 2 parts sand.[c]	1 part cement, 3 parts sand.[d]
rtar made up into briquettes immediately after nixing.	651 650 673 634 679	624 701 624 581 610	527 493 529 480 492	417 385 421 403 409
Average	657	628	504	407
rtar allowed to take initial set, then broken up nd made into briquettes.	671 593 644 633 724	692 670 654 676 700	589 554 559 534 532	326 349 330 358 267
Average	653	678	554	326
rtar allowed to take final set, then broken up nd made into briquettes.	455 522 525 558 642	527 569 587 566 568	492 491 497 486 531	364 380 361 315 345
Average	540	563	499	353

[a] Initial set, 1 hour 42 minutes; final set, 7 hours 15 minutes.
[b] Initial set, 1 hour 30 minutes; final set, 7 hours 15 minutes.
[c] Initial set, 2 hours; final set, 7 hours.
[d] Initial set, 2 hours 20 minutes; final set, 7 hours.

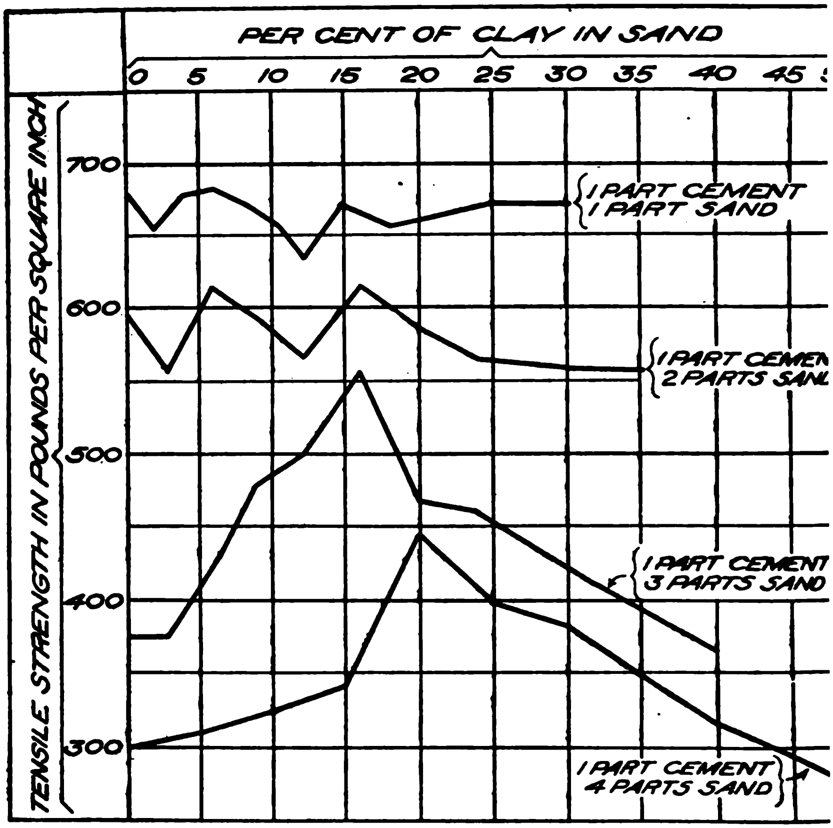


FIG. 14.—Diagram showing the effect of clay on cement mortars.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 236.

CUBATION AND INCUBATORS.

BY

RICHARD H. WOOD, M. D.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 25, 1905.

SIR: The large and constant demand for information concerning incubators led to the publication in the Twenty-first Annual Report of this Bureau of an article entitled "Incubation and Incubators," by Richard H. Wood, M. D. It seems desirable to publish this article separately for use by those people who do not possess a copy of the complete report, and I therefore recommend its publication as a Farmers' Bulletin.

Respectfully,

A. D. MELVIN,
Acting Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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INCUBATION AND INCUBATORS.

PRELIMINARY REMARKS.

During the past century great progress has been made in nearly all nes of agriculture, and poultry raising, now recognized as an im-ortant branch of agriculture, has advanced with other lines. It has ecome a trade, an art, and a profession. Nor has any other nation ade greater progress in poultry raising than has the United States. oultry raising has been given abundant space in our agricultural urnals and place in our leading agricultural colleges.

This article deals entirely and exclusively with the hatching of ggs, or incubation, natural and artificial, and to be complete it ust treat of both the egg itself and the means employed in hatching.

Many farmers regard the incubator proposition as one out of their ne of study and practice. To them natural incubation is too simple demand consideration and artificial incubation is too complicated r anyone but an expert. To bring the farmer into closer sympathy ith this article it may be well to state that the writer has taken a reat and active interest in the subject of incubation for the past irty years; and, while he has been successful, he has made some ilures and met with some disappointments, just as others have one and as many will do until by study and practice they acquire at skill which after all is fully as necessary to success in other lines in this.

IMPORTANCE OF THE INCUBATOR.

Poultry raising is one of the important features of farm work. he incubator is an important factor in poultry raising. It is a ccess; it has come to stay; and the time is not far distant when it ill be as necessary upon every farm as is the plow, the mower, or the parator. It is a machine the operation of which is simple. It lls for no hard or heavy manual labor. A woman, a child, or en a crippled or invalid member of the household may learn to erate an incubator easily and successfully. To make this possible d to bring a practical knowledge of this subject to every farmer or her interested person in our land, is the aim of this article.

In order to make this article of the greatest value to all, it must appeal to the manufacturers of incubators as well as to the users of them. Hundreds of most excellent incubators are being made and sold, but they are forced to compete with almost as many that are inferior and imperfect if not positively defective. Now, every imperfect machine put out is a serious damage to the incubator business. The purchaser of an inferior machine, failing to secure good results, sets aside his incubator and informs his neighbors that artificial incubation is a failure. On the other hand, the purchaser of a good machine—one properly made and adapted to its work—is so apt to be pleased with his success that he encourages his friends and neighbors to undertake raising chickens with incubators. At this point it seems proper to answer the question, asked so frequently, "Is there not some danger that so many will embark in this business that it will be overdone, and the markets be overcrowded with poultry and eggs?" Answer: No; the demand is constantly increasing, and more production will be followed by increased consumption. As fast as a regular supply can be depended upon, to the same extent will consumers learn to avail themselves of that supply.

Again, not everyone who has gone into the poultry business will remain in it. Many will not find it to their liking, while others will not have sufficient energy and persistence to learn its details. The poultry business is one of the most stable lines of business in the world to-day. Its products are always in demand in every town and city in the world. No prejudice of religion or caste stands in its way. Sales are not limited as to locality or season. When the use of the incubator becomes known, when farmers generally become acquainted with its management and its many advantages, then will the public learn that the supply of poultry products is regular, and then will the use of these products be greatly increased.

A STUDY OF EGGS FOR INCUBATION.

First in order, then, comes the study of the egg itself. The writer does not propose to enter into an essay upon embryology. It will be sufficient for our purpose to say that the egg must be fertile, or hatchable, and this brings us at once to the subject of fertility.

An egg receives its fertility from the male bird, but the condition of the female at the time of laying has much to do with the hatching quality of the egg. This should not be regarded as a statement of a far-fetched notion, but as a fact that has been noted and demonstrated time and time again in the writer's own experience. The laying hen must be healthy and properly fed or she can not produce an egg capable of carrying the germ to a successful hatch. Hens kept in unhealthful quarters or too closely confined are not likely to lay eggs that will produce strong, healthy chickens, if indeed they produce any whatever. Hens suffering from disease or infested with vermin may lay, but eggs from such hens will rarely hatch, and even if they do hatch the chicks will not be likely to mature into vigorous or growthy fowls. Hence in order to secure hatchable eggs the hens must be healthy, have plenty of outdoor exercise, and be fed upon an assorted or balanced ration. An exclusive corn diet will not make for fertility. Fowls in confinement must have a mixed diet and plenty of grit and bone, with meats, clovers, or other substances in the line of nitrogenous food. They must be kept free from lice and must have plenty of litter, straw, hay, chaff, or leaves in which to scratch. Fowls having free runs need less attention to diet and are more apt to lay fertile eggs than fowls closely imprisoned. Many different ideas prevail as to the number of hens that should be allowed to a cock. In this matter much depends upon the breed of fowls, much depends upon the way the fowls are kept, and much depends upon their ages and condition. One should exercise some oversight as to the matings of his fowls and regulate the size of his breeding pens accordingly. With most breeds we get a larger percentage of fertile eggs from a mating of a number from ten to twelve hens to one cock. Eggs may be fairly safe from a pen of twenty hens with one good, vigorous, young male bird. Some advise keeping but two or three hens with a cock, but in the writer's experience such matings are generally unsatisfactory. The male will so worry and annoy his small flock that but few eggs will be produced and few of them will be fertile. Besides this, two or three hens confined in this way are apt to become jealous, nervous, and quarrelsome. The same cock, if given a larger flock, will keep them harmonious and contented. With these ideas in mind it is safe to recommend that a breeding pen shall consist of from seven to fifteen hens and one cock, and the latter should be strongly bred, in good health, and known to be vigorous. But some recommend keeping more than one male bird in a flock. This may do, but where this is done it is wise to have a comfortable and convenient coop in which to keep one of the cocks, and then by a system of catching up one cock and releasing the other every night give each one alternately a day of rest or a day upon the walk. Another advantage in this system is that the cock has a chance to feed by himself part of the time and can be kept in a more thrifty and vigorous condition than if upon the walk all of the time.

It is highly necessary that the amateur or the novice shall be impressed with the fact that the fowls from which eggs are saved for hatching must be strictly healthy, must have a reasonable amount of exercise in the open air, besides an abundance of strictly fresh and pure water, and a great variety of wholesome food. Even under the most favorable circumstances the eggs will vary to the extent that there is room for selection. Select eggs of a medium size and an average as to color and shape. Let the selection be influenced by the average product of the hen or breed. An unusually large egg for the breed or hen may be a monstrosity and can not be expected to hatch. An unusually small egg may be defective and should not be incubated. An egg of unusual length or one of unusual rotundity should not be placed under a hen nor in an incubator. An even, uniform lot, assorted as to size, color, and shape, will be apt to give the best results. Freshness is a prime necessity. While an egg six weeks old may hatch, the chick will be weak and hard to raise. Fresh eggs hatch earlier, and the chicks from them are stronger than those from older eggs. As a rule, eggs more than twelve days old should not be placed in an incubator. This is one of the reasons why eggs from a flock numbering from ten to twelve hens are more apt to hatch than are eggs from a flock of only three or four hens. They do not have to be stored so long before getting a sufficient number for a setting. Eggs for hatching should be clean; if not clean they should be washed in tepid water and carefully dried with a clean, soft cloth. This washing does not injure the egg, but it must be done quickly and carefully, or the jarring of the contents may ruin it for hatching. As fast as the eggs are washed and dried they should be covered with a layer of clean cloth or absorbent cotton to prevent their becoming chilled. It is good practice to stand the eggs in a cool quiet place, each with the large end uppermost, for a period of twelve hours before placing for incubation. This balances the yolk in the center and locates the air cell.

In this connection it is well to bear in mind that eggs laid the day they are set will hatch several hours earlier than those that are a week older.

Eggs waiting for incubation should be kept at a temperature of about 60° F., although they will stand a variation of temperature from 40° to 100° F. They should not be allowed to dry out, nor should they be exposed to a current of cold air, steam, or vapor. During storage, eggs for incubator use should be partly turned every day. A little attention to these simple directions will make quite a difference in the possibilities of fertile eggs and will greatly augment the percentage of chicks.

It is poor practice to set eggs of more than one kind or breed together in the same machine, for eggs of different kinds vary in thickness and strength of shell and in the amount of heat and moisture required.

So much, then, for the subject of fertility, all of which can be summarized in the following brief maxims: The breeding stock must be healthy and properly fed, watered, and exercised. Eggs must be carefully and promptly gathered and cared for. The egg has as much to do with the result of incubation as has the incubator. The machine should not be blamed for failing to hatch a defective egg.

INCUBATION.

The history of incubation is rather obscure. Natural incubation, which is dependent upon the instinct of the mother hen, seems to be conducted by the modern hen in just about the same manner as that of the barnyard fowl of fifty or more years ago. Artificial incubation, or hatching by machinery, is known to be an old idea, and yet very little information upon original processes is to be found in our libraries. Eggs were hatched by artificial means centuries ago. Machines were invented and used successfully for this purpose by the Egyptians long before the Christian era. Very recently some of these hatching ovens have been found by explorers. Some of them depended upon the customary fuel for their supply of heat, while others relied upon stones heated in the sun, and some, even, were found that obtained the necessary heat from lamps. Besides the above sources of incubation heat, mention can be made of decomposing animal and vegetable matter used long ago with unknown success. Not many winters ago the writer had the pleasure of forking out a live and healthy chicken from a heap of compost near the door of his stable. Numerous other instances of accidental incubation have been related, and man's ingenuity has been exercised to devise machines and methods that will insure the transition of the dormant egg into the living chick.

The whole theory of incubation is based upon the fact that, if a fertile egg is kept for a sufficient period of time under certain conditions of heat, moisture, and position, it will be transformed into a healthy fowl.

The period of incubation varies with different species of fowls. The average period of natural incubation is a little over twenty, or about twenty-one days, for the egg of the common hen. This period may be somewhat shortened or prolonged by variations in the conduct of the mother hen, and possibly by changes in the weather. Should the weather be moderate and the hen quiet and faithful, we need not be surprised if the eggs are all hatched by the close of the twentieth or even the nineteenth day. Again, if the weather be extreme or the hen restless and neglectful, we need not look for all the eggs to hatch until the close of the twenty-first or the beginning of the twenty-second day. The same applies to eggs from other fowls, except, of course, that each has its own period of incubation, subject to the variations mentioned. The following table is accepted by most poultry men and writers upon natural history and is approximately correct:

Period of incubation.

Name of fowl.	Days.	Name of fowl.	Days.
Common hen	21	Goose	[illegible]
Pheasant	25	Partridge	24
Duck, common	28	Duck, Barbary	[illegible]
Peafowl	28	Turkey	[illegible]
Guinea	25		

In spite of all notions to the contrary, the process of hatching can be suspended and held in check for several days without total destruction of the germ. This fact is of practical importance and, if remembered, may save the breeder a good hatch when, because of some accident or oversight, a lot of eggs has been left without outside heat and allowed to cool. Such eggs, if placed at a proper temperature, may hatch fairly well, provided this temperature is maintained a few days longer than the usual period of incubation. The writer has known hatching to be delayed to the twenty-second and, in one instance, until the twenty-fourth day by accidents to his incubators. Hence, where accidents of this kind occur it is wise to keep the eggs warm a day or two overtime, with the expectation that, while incubation may be delayed, the germ is still alive and will develop. This brings to mind one of the greatest advantages of the incubator to the farmer or the farmer's wife—to people who are accustomed to rely upon the mother hen and prefer to raise chickens by natural incubation. Many times the hen will get sick, will die, or without any apparent excuse will leave the nest, and unless another hen is ready to take her place the eggs will spoil. A small incubator in the house will be found useful upon such occasions. The eggs can be removed from the nest and placed in the warm incubator and hatched or kept there until another hen is ready to take up the work. For this purpose alone an incubator is worth its price to any farmer who raises poultry. Many times has the writer saved valuable clutches of eggs by the use of one of these machines when it was found some perverse hen had deliberately abandoned her nest.

THE INCUBATOR.

The egg, its fertility, and period of incubation being now disposed of, the next item for consideration is the machine used in artificial hatching, or the incubator. There are so many different kinds of machines used in hatching eggs that a description of all of them is quite impossible in an article of this kind. At the present time they are all constructed upon similar principles and along the same lines, and nearly all of them derive their heat from lamps that burn kerosene. In some of the hot-air machines the heat is applied through the medium of heated air, while in others—the hot-water machines—the eggs are supplied with heat from pipes filled with hot water.

HOT-AIR INCUBATOR.

In the hot-air incubator a common kerosene lamp is used to furnish the current of hot air which passes over and around the egg chamber and which keeps the eggs at the proper temperature for hatching. Like the hot-water machine, it is supplied with a regulator, which, acting upon a valve or damper, regulates the admission of heat to the egg chamber.

HOT-WATER INCUBATOR.

In this incubator water is heated and forced through metal tubes over the eggs, thus distributing heat throughout the egg chamber. It is supplied with a regulator which works upon the same principle as does that of the hot-air machine.

PARTS OF AN INCUBATOR.

The selection of the lamp is so important that the writer deems it his duty to warn all poultry men against buying a poor lamp. Manufacturers, as well as purchasers, should remember that while the lamp is half the incubator the burner is half the lamp.

Reservoir of the lamp.—Some remarks on the different parts of an incubator are now in order. First, let us consider the lamp, which is the primary source of heat in both hot-air and hot-water machines. Many kinds of lamps have been tried and many patents have been granted upon lamps and parts thereof for incubator use, but the tendency is to discard all that are in any manner complicated and to return to the plain, old-fashioned burner and chimney. The oil reservoir should be made of metal, either copper or galvanized iron, as those made of glass are too liable to break and are too heavy to handle conveniently. This reservoir should have a flat bottom and a flat top. It should have a capacity exceeding the twenty-four hours' demand of the machine. This is very important, for sometimes it happens that the operator is detained for some reason and can not reach his machine at the proper hour, and in such a case the lamp must contain oil enough for a few hours overtime. This reservoir should be plain and smooth outside and inside. It should be well made and well finished, having no rough projections or slivers of metal or solder to catch the hands, the clothing, or the cleaning cloths. Attached to this reservoir, or body of the lamp, should be a good, strong handle large enough for the hand of the operator. Better no handle at all than one that is slender, sharp-edged, flimsily attached, or too small for the use of more than one or two fingers. Select a lamp with a handle that is broad, strong, smooth, and firmly attached. The lamp is for use, and it should be built to stand handling. It must be strong in order that it may be convenient.

Burner.—The burner is the very important part of an incubator lamp. It should be made with the greatest regard to stability and accuracy. The flat-wick tube is the most common, and, when the burner is properly constructed, it answers every purpose. But many manufacturers are careless about the quality of their burners, and are sending out flimsy and poorly made articles that are difficult to manipulate and are imperfect in action. A little carelessness in selecting a burner has led to the condemnation of many a good incubator. The burner should be made of good material, such as brass or copper, and never of poor material, such as iron or plated tin. The wheel or lever used in raising and lowering the wick must be stout, large enough for its purpose, easy to find, and must turn exactly and easily. Never waste any time upon a burner that does not work promptly and readily, so far as the wick is concerned. If it turns hard, or does not turn to the thirty-second of an inch, it is useless and will cause trouble.

The tube holding the wick should be strongly made of material that will not break, spring, or bend, and it should be so adjusted to the size of the wicks furnished with the outfit that the wick can pass up and down freely without pinching or binding. On the other hand, it should not be so large or loose as to allow the escape of gas along the side of the wick. In one case the pinching of the wick will interfere with capillary attraction, and in the other the looseness of the wick will cause an uncertain or unsteady flame. The wick tube should be perfectly true and smooth across the top. A rough edge with notches, depressions, or projections of metal or brazing will make it difficult to trim the wick; and a poorly trimmed wick gives off an uncertain degree of heat. Alongside the wick should be a small tube for the escape of surplus gas or vapors from the reservoir, but this tube must never project above or even to the top of the wick tube, for if it does it will interfere with trimming and be likely to fill with cinder or soot.

Herewith (fig. 1) is an illustration of a burner that is well constructed and has given excellent satisfaction.

The space under the wick screen should be wide open. The hinge to the cap should be very strong and work freely to the fullest extent. The snap, or catch, to the cap should have proper strength and tension, and should fasten the wick cap firmly to the burner. Every detail should be examined before the burner is sold. The following questions should be settled before the lamp is packed for shipment: Does it leak? Does it fit? Does the elevator turn easily and accurately? Is the wick tube perfect? Is the top of the wick tube level and smooth? Can the wick be trimmed nicely? Has the burner a chimney that has been made to fit? Does the screw or snap that fastens the chimney work easily and properly? Does the thread of the burner fit the thread in the socket of the lamp? This last question may seem unnecessary, but the writer has purchased incubators having burners which could not be turned into the lamp. All these little matters count and have much to do with the success or failure of the hatch.

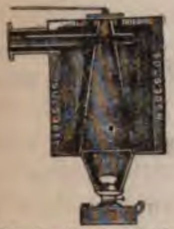

FIG. 1.—Sectional view of a good lamp.

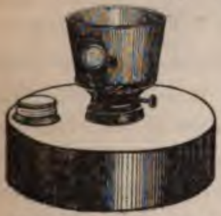

FIG. 2.—One of the best chimneys.

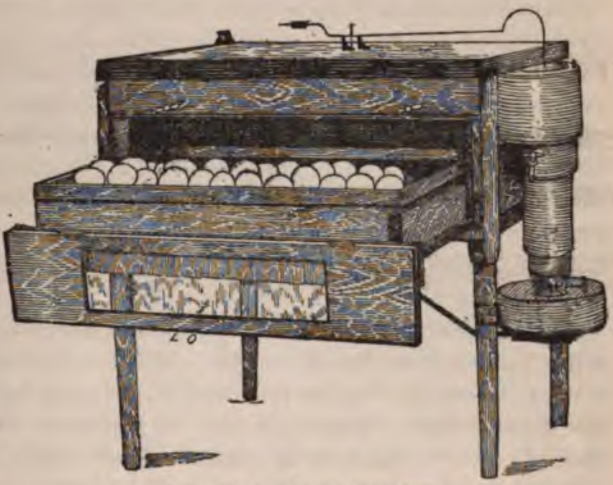

FIG. 3.—A good lamp in position.

While some of the imperfections of a lamp are visible, others can not be discovered until an attempt is made to use the lamp in heating an incubator, or to clean, trim, and fill it. Figure 1 shows a good lamp.

Chimney.—The chimneys of different makes of incubators vary greatly in form. Few are well made, whatever their shape. The base or lower circumference should be smooth and level. The spiral or bevel of conical chimneys should be so cut that the chimney stands plumb when on the lamp. The top circumference should be smooth and without slivers upon the edge to cut the hands or catch the cloth in cleaning. The mica front should be large enough to show the full width and height of the flame, and this mica should be fastened neatly and securely. Allowance should be made for contraction and expansion. Referring again to the forms of chimneys, the writer has derived most satisfaction from those of a cylindrical outline. They are preferred to those of a conical outline, although those of the inverted-cone form are convenient to handle and, because of their wide, open tops and short canal, very easy to clean. Figure 2 is an illustration of a most excellent chimney.

Nearly every incubator catalogue describes its lamp in glowing terms, but a large number of the lamps sold are useless and discredit their manufacturers. It would cost but little more to make them better, and, if they were properly inspected and tested before shipment, it would hardly be necessary to devote so much space to this subject.

Wick.—Nothing has been found yet that takes the place of the plain cotton wick. Other materials have been tried in the so-called "wickless machines," but while wicks of these new materials are more durable than cotton, they need about the same attention in cleaning if not in trimming. The wick should be of medium weave and some firmness and be made to fit the burner in which it is to be used.

Body of the incubator.—The body of an incubator should be mounted upon good strong legs and at a reasonable height from the floor. If too high or too low, the machine is very inconvenient to operate. The writer prefers that the top of the incubator be about 36 inches from the floor. Manufacturers of incubators should remember that these machines are moved about and are sometimes required to carry weight, and they should furnish them with legs for utility rather than for ornament. The body of an incubator should be made of nonshrinkable material and should be air-tight and have well-fitted joints. None but the very best of workmen should be allowed to work upon an incubator. More depends upon a good carpenter than upon a good painter, and the value of any incubator lies, not in how well does it look, but in how well it is made. The walls of the body should be three in number, making two air spaces, and each of these three walls should be well constructed and with good tight joints. If each of these walls is not tightly made, then the manufacturer should not boast of his air spaces, for an open space can not be called an air space. The outside surface of the body should be of smooth finish. Seams, fluting, beadwork, and unnecessary ornamentation should be avoided. It is easy to see how vermin can infest an incubator that is made of beaded matching. The top of an incubator should be smooth and unincumbered. It is useful as a work table in testing, cooling, or turning eggs, and it should be a clear, free surface. It is quite an inconvenience to have part of the regulator upon the top of the machine. A good feature of some incubators is that they have the regulator either at the end of the machine or under cover, if at the top of the table.

The inside of an incubator, or the space known as the egg chamber, should be well finished. No bad joints and no slivers or other evidences of bad workmanship are allowable. The trays should be smooth, well made, and should slide easily upon the tracks. If the trays stick or hang when being drawn out or pushed in, the machine is defective and should not be accepted by the purchaser. Such a defect will not cause loss of time and patience merely, but it may cause the loss of a trayful of eggs. The space called the "egg chamber" should be deep enough from above downward, or, as carpenters express it, "high enough between joints," that the trays and eggs have plenty of space, and so that when necessary the hand or thermometer can be passed back over the eggs. This is important. There should be at least 3½ inches space between the top of the eggs and the heating tank. Convenience and evenness of temperature both demand that the top of the eggs should not be too near the source of heat. Besides this point, the air around the eggs will be better because of this space.

The nursery, or chick space below the trays should be ample. From the bottom of the tray to the floor of the nursery should be a space of nearly 4 inches. This space will give the chicks in the nursery a chance to stand erect and also allow the trays to be moved in or out without danger to the youngsters below. One of our best incubators is faulty in this respect, and, while it is a very successful hatcher, it decapitates or otherwise injures several of the chicks every time the tray is drawn out or replaced. Better no space below than a space that is too limited. The removable nursery is one of the most valuable improvements that has been made in incubator attachments for many years, and all who have used it agree that no machine is complete without it. It gives an abundance of room for the chicks as they drop from the tray above and it permits the removal of the chicks from the nursery without disturbing any unhatched eggs that may be left in the tray. The bottom of the nursery is covered with a canvas carpet so that the chicks will not be lamed or injured by slipping. The floor of the removable nursery is usually attached to the front of the egg chamber at right angles and in such a way that the whole nursery can be drawn out as easily as one usually pulls out the drawer of his desk. Such an arrangement makes cleaning and inspection easy, besides giving one access to the chicks in cases of partial or delayed hatches. It also makes it possible to use the nursery to its greatest advantage. The first twenty-four hours are very important ones in the life of a chick and a properly constructed removable.nursery is the best place that has been found for its safety and welfare. The illustration (fig. 4) represents a movable nursery.

Although allusion has been made in the preceding lines to the tray, still a few more words seem necessary before passing the subject. The tray should be strongly made of well-dressed material well put together. It should not spring nor sag when loaded with eggs. It should be made of soft wood, and the nails and screws used should be long enough to hold the parts firmly together. A flimsy or poorly made tray is to be avoided. It means loss of time and loss of eggs by breaking. The writer once bought an incubator the trays of which were put together with carpet tacks and screws too short to hold the different parts in position. The attempt to use was accompanied by the loss of nearly a trayful of eggs, and he hopes that his readers will profit by his experience and examine all trays carefully before setting up a new incubator. Many trays are partitioned by wire into small spaces, each capable of holding five or six eggs. As a rule such trays are unsatisfactory. A simple division by three-cornered wooden strips into transverse rows or ranks is highly satisfactory, and it is preferable to any other form of tray. The edged strips of wood stiffen the tray without encumbering it, they take up no egg room, and do not interfere with the process of turning. The tray must not be allowed to slide all the way back against the wall of the egg chamber. A space of at least 2½ inches should be allowed between the tray and the back wall of the machine. A block should be fastened to the top of the track at its farther end to prevent the operator from forcing the tray back and closing up this space. This is important, as the chicks are apt to be pinched, crippled, or killed if the tray

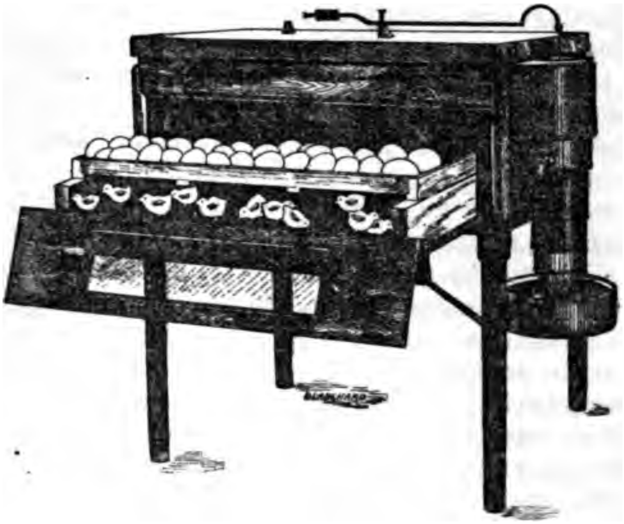

FIG. 4.—Removable chick tray and nursery—an indispensable adjunct.

n be pushed too far back. A similar space should be allowed between the front edge of the egg tray and the door. The chick needs this space when it drops from the tray to the nursery.

Returning to our consideration of the body of the incubator, much can be said about the arrangement of the door, or hinged window, in front. Select a machine with a double-glass door. The two layers of glass must have 1 inch of space between them so that they can be cleaned. Many manufacturers are careless about the fit of the door. It should open and close easily, but snugly. If it does not open and close easily, one is liable to jar the eggs and disturb the level of the incubator. The sash of the door should be heavy enough for strength, but not so wide as to interfere with the view of the eggs or the thermometer. The glass in the door should be wide enough in the perpendicular to afford the operator a full view of the egg chamber without stooping or kneeling. It is not a view of the wooden edge of the tray that the operator wants; it is a view of the thermometer, the eggs, or the chicks. The glass should be located so as to permit this view, but if the glass is too narrow or not properly placed, or if the margin of the sash is too wide, the window will be of little value to the operator. This matter is worthy the attention of the manufacturer, for there is quite a prejudice against a machine the temperature of which can not be watched without the removal of the thermometer from it. Many manufacturers send machines with doors imperfectly fitted, the glass of which is covered with paint, putty, or varnish, which can not be removed, and it is impossible to read the thermometer through such doors. Once more purchasers are warned to avoid the machine that will not permit them to read the thermometer without opening the door. Manufacturers should bear in mind that the light should strike the egg tray from above instead of from below.

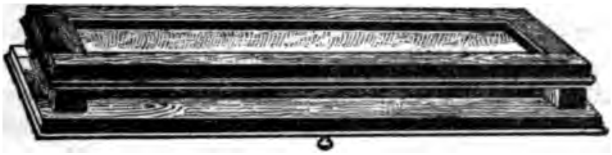

FIG. 5.—An up-to-date door.

Thermometer.—It is really surprising that up to the present time so little improvement has been made in thermometers. An instrument of this kind should be plainly legible and it should be convenient to handle. The usual practice of glazing the back of the tube with white porcelain makes the reading of the temperature very difficult. There seems to be no good reason for this. This white background makes a grayish shade, the [illegible] column, and unless the light is very good [illegible] the right direction it is almost impossible to ascertain the temperature without removing the thermometer from the machine. This is bad, as the column is likely to contract or expand while being conveyed to the light. The column should be large enough to be seen from a distance of at least 4 feet, and the markings and figures should be few and very plain. Many of the frames in which the glass is set are cumbersome, take up too much room, obscure the view, have sharp corners or long legs to catch upon the tray or sleeve, and yet are too unstable to stand alone or stay where placed. A thermometer with a red or green background, a large mercurial column, a few plain marks and figures, and mounted upon a convenient yet substantial frame will be a boon to poultry men. Improvements will be made, and it is well for purchasers to ask for the latest and the best. In connection with thermometers it is well to state that the so-called "magnifying lens" is a failure and much more difficult to read than the plain round tube unless it is held in exactly a certain position with reference to the light. The thermometer tube need not be over 4 inches long, and the less metal it has attached to it the better. In regard to the accuracy of the thermometer, almost any physician will test it for you by the side of his clinical thermometer, which has about the same scale and range.

Regulator.—Many are the methods that have been tried for automatically regulating the temperature of the egg chamber. So far all of them depend upon the principle of contraction and expansion. The demand is for some simple device that will allow the temperature to rise so high and no higher, and that will maintain the temperature at that degree regardless of the weather or external influences. Most regulators act upon a damper over the top of the lamp, and, by opening or closing the same, regulate the amount of heat that passes into the incubator. The expanding horseshoe-shaped bar, the elliptical spring bar, and the metallic disk are the most common regulator powers of the present. Perhaps in the course of time some one will make a regulator from a coil or spiral spring that, reaching clear across the top of the egg chamber, will very accurately control the admission of heat.

At the present time the best regulator is the double disk, whether filled with air or with liquid. Excellent results are obtained by using the single disk, but the double disk is still better. The disk, in order to be useful, should be large enough to have some force and to note the slightest variation in temperature. A disk of only 1 or 2 inches diameter has hardly power enough, nor is it delicate enough for quick and perfect action. The writer prefers the double disk and that with a diameter of 4 or 5 inches. Such disks will be very susceptible to changes in temperature and will be strong enough to act upon the damper. Of course there are machines that use the horseshoe or buggy spring expanding bar, which work fairly well; but as fast as possible the writer has these attachments removed and the disk substituted for them. Many purchasers have no patience with a regulator that will not work from the start, and, owing to the fact that first impressions are prejudicial, it is safer to ship articles that will go together readily and work from the start. There is something in the location of the regulator. The disk should be placed near the center and well toward the back of the egg chamber. It should be placed so high that it is not in the way of the eggs or the tray. Another reason for placing the disk high is that, because the chicks as they hatch will tumble around more or less before dropping into the nursery, one or more of them may hit the regulator, thus disturbing its adjustment and bringing disaster to the remainder of the hatch. The regulator should be strongly fixed in its bearings, so that an accidental touch will not put it out of order.

Most machines have the long bar or damper lever upon the top of the body. This is a serious fault. The top of the machine is the most convenient table for cooling, testing, or turning eggs, and it should be free and clean for that use. Besides this, the lever, when located outside and upon the top of the machine, is easily affected by a current of air and also liable to become bent or dislocated. A child, a stray fowl, a mouse, a cat, or a slight breeze will be likely to interfere with the action of the regulator if it is exposed upon the top of the incubator. Some makes of incubators have the damper lever at the end of the case; others have it above the egg chamber, where it is covered and protected. The adjustment of the regulator should be perfect and accurate. Threads should be true and cut to fit the bur; rods should be of proper length and, if weights are used, they should be so arranged that they can be fixed in the proper position. The writer sees no use for the weight, nor does he favor a very long lever. By principle of direct action the damper is its own weight, and with the disk regulator no other weight seems necessary. In some machines the regulator is cumbersome, takes too much space in the egg chamber, and interferes with the handling of the trays; in others it is loosely set and constantly getting out of balance and dropping down upon the eggs or chicks. The disk regulator is less in the way and less liable to fall down than any other that the writer has used. Figure 6 shows a good regulator.

Few machines are perfect in all their parts, but when one is found that suits in most details it is kept and remodeled to suit everyday requirements. Most manufacturers make a mistake in their failure to test every machine as a whole before sending it out. Made of the same materials, from the same patterns, by the same machinery and the same workmen, all mechanical products are liable to vary somewhat in their action. Each incubator has an individuality, and it requires a thorough test at the factory.

The purchaser can feel assured that plenty of incubators are now made by firms that test them in the shops and whose regulators can be relied upon as surely as can a watch or clock. Defects have been mentioned for the good of both manufacturers and purchasers, as the author firmly believes the incubator to be a staple article of manufacture and use, and a money maker for the intelligent and persistent operator.

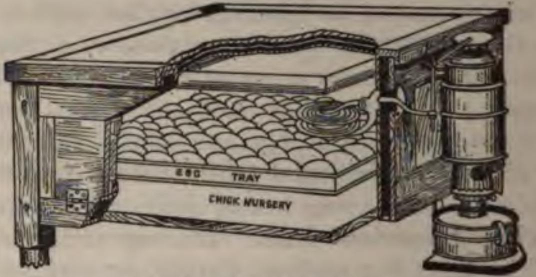

FIG. 6.—A good regulator.

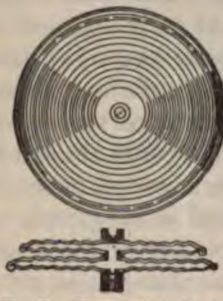

FIG. 7.—Thermostat—front and sectional view.

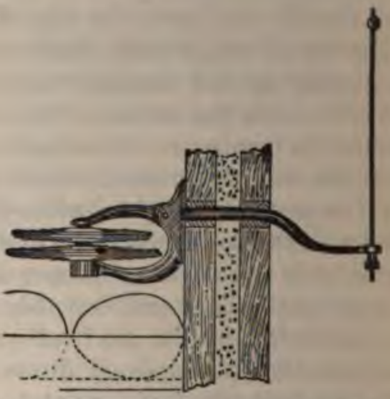

FIG. 8.—Thermostat—side and sectional view.

Ventilation.—So much has been written upon the subject of ventilation that the reader need not expect the writer to add much that is new to the literature upon this subject. One thing is sure, namely, that in nature the mother hen is compelled to allow fresh air access to her eggs. But she frequently makes her nest in places where the air is far from good, and yet she gives us a fair hatch regardless of atmospheric surroundings. It is not likely that frequent currents of fresh air over the eggs are necessary to successful incubation, nor does it seem certain that air in motion, even if it has been warmed, s inclined to promote hatching. If the machine is opened twice a day and the eggs taken out to be cooled or turned, they get about all the ventilation they really need. But accidents may happen: there may be leaking of steam or smoke, or a breaking of an overlooked decomposing egg, and, for fear that such an accident may happen between the hours of inspection, it is well to have a system of moderate ventilation in operation. One of the best methods is a circular hole in the bottom of the machine, this hole being about 1½ inches in diameter and covered with fine wire screening on the inside and provided with a slide of tin or other metal upon the bottom or outside. This slide should be open when the machine is first heated. It should work easily and be slightly open all the time, and should be altered according to the weather. One thing often overlooked is the quality of the air in the room occupied by the incubator. The room should be clean, free from dust and mold, moderately dry, and contain air of absolute purity. This has more to do with the condition of the air in the egg chamber than many are inclined to admit, and is, in the writer's opinion, the major part of ventilation.

Moisture.—This is another topic that has been freely discussed in the poultry journals. A great many different plans have been advocated for keeping the air in the egg chamber properly charged with water. The simple plan of placing in the bottom of the egg chamber a saucer containing a small wet sponge is as good as any. There does not appear to be any better method than this of rendering the air around the eggs humid. The amount of moisture required is so little and varies so much under different circumstances that the ingenuity and judgment of most operators can be relied upon to provide moisture as needed. If the incubator is operated in a cellar or basement, the air will probably be damp enough without the further introduction of moisture into the egg chamber.

SUMMARY OF THE DEFECTS OF INCUBATORS.

The following summary of faults most frequently found is here appended: Poor material, poor workmanship, and poor arrangement are all to be condemned. Machines of poor construction, or constructed out of refuse material from other lines of manufacture, will no longer satisfy the up-to-date poultry man. Incubators made out of the odds and ends of other goods, or with coarse, dull tools, are no longer in demand. Machines made by men who know nothing about the poultry business, or who take no interest in that business and lack experience in operating incubators, are likely to prejudice the public against the use of all incubators. The inspector should be competent. If he does not know how to test every part of a machine and exercise thoroughness in his work, one can hardly expect the output of his factory to give satisfaction.

SUMMARY OF THE GOOD POINTS OF AN INCUBATOR.

On the other hand, good material, good workmanship, and adaptability of parts, or such arrangement of the various parts of the machine as shall make it efficient, practical, and convenient, are desirable. Two dead-air spaces, good strong legs, plenty of space in the egg chamber, good windows properly placed, a good thermometer located where it can be read without disturbing the machine are all necessary and among the strong points of a good incubator. In addition to these, there are a good lamp—one with a good burner and good chimney—a good regulator, a good strong tray properly placed, and a good roomy removable nursery tray below. All chips and shavings should be removed when the machine is inspected or before shipment. Makers of incubators must not lose sight of the fact that the construction of an incubator is a living problem. It has to do with the promotion of life and is not a mere matter of iron and wood. This business requires more skill and better workmanship than does the construction of thrashing machines and fanning mills. This machine operates upon living products and it must bring forth living creatures, else it is useless.

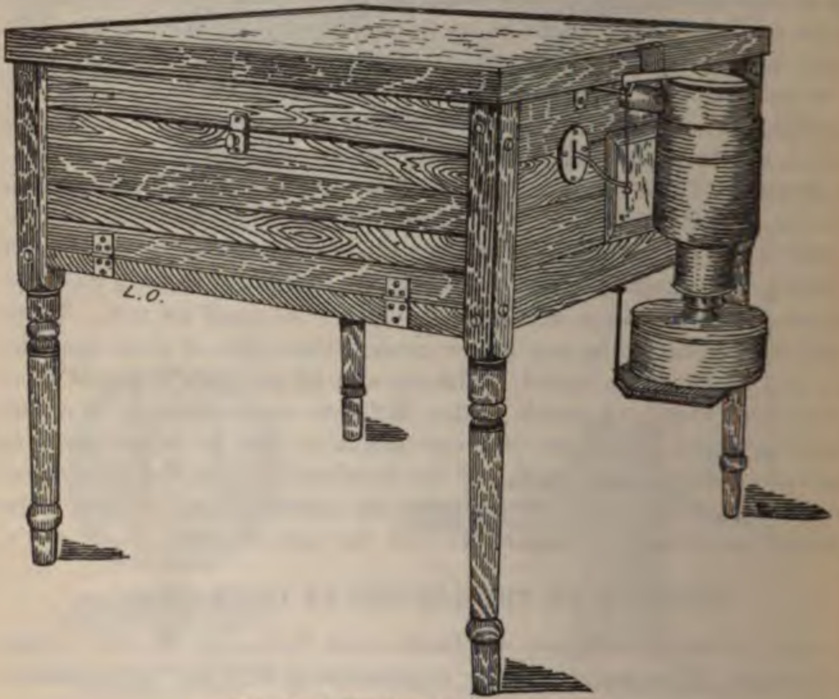

Fig. 9.—A first-class hatching machine.

Purchasers should be cautioned against buying an incubator of rge size for experimental or farm work. The so-called 100-egg size s large enough for the beginner. One tray and one egg chamber are nough.

HOW TO OPERATE AN INCUBATOR.

The agricultural papers and poultry journals are full of information upon the management of incubators, and many books have been published to furnish instruction upon this subject; but a great many farmers do not see these journals or the books. Once let it be known hat the operation of an incubator is easy and simple, and once the lmost superstitious dread that some people have of taking up something new is overcome, there will be little trouble in teaching the ses and management of the common hatching machine.

At the outset the writer insists that the successful operation of an ncubator depends upon ccuracy and exactness. Not only should the work be done properly, but it must be done "on time." The woman who fills her lamps at a certain hour of the day, and the man who winds his watch or clock at the same hour every evening, need not fear the task of running an incubator. But unless one is willing to study, to read, and to practice, and is willing to attend to the few wants of his machine at the right time, making a specialty of promptness and punctuality, it will be unreasonable to look for chickens from the best incubator under his management.

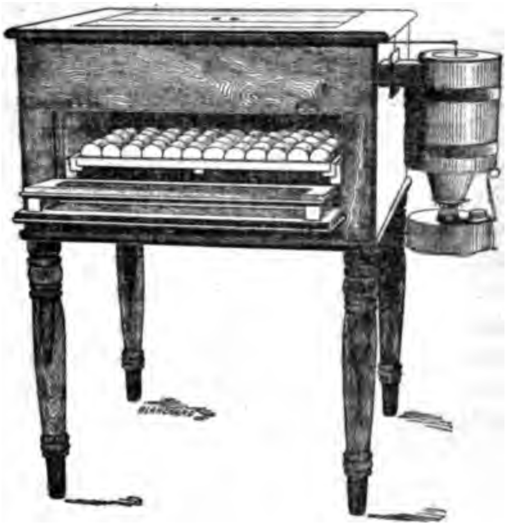

FIG. 10.—One of the best Incubators.

The person who runs an incubator must be clean and careful; he must be at home with his machine at the same hour every morning and the same hour every evening; he must learn the peculiarities of his incubator and carefully follow instructions. For such a person he operation of the ordinary hatching machine will be simple and asy enough. With each shipment the manufacturer [illegible] out a ook or card of directions. Read this carefully [illegible] et up the machine. Put the parts together [illegible] these directions. Count the parts and inspect them carefully; then put them together; see that the machine stands level; that the doors open and shut easily; that the regulator is in working order.

About this time comes the question, Where shall we set this machine? This matter of location is very important. It has much to do with success in hatching. First, it must have some permanency. It must be placed where it will not be disturbed, away from jars and vibrations, out of all drafts or where the breeze can not strike it and where the opening and closing of doors and windows will not affect it. The room occupied must be large enough and have a level floor. One needs room to work about an incubator. It should have a clear space around it, especially in front, and at the lamp end of the machine there should be plenty of room. The apartment should not be damp or dark. A clean, dry, light cellar is excellent for this purpose. Any dry, clean room will do, but, as before stated, drafts or currents of air over or around the machine are very detrimental. There should be no stove or other source of artificial heat in the room occupied by an incubator. The entire room should be clean and free from dust. Some of these items have been mentioned in the preceding lines, but their importance warrants a repetition here.

Common sense and circumstances will dictate the location of the machine, but the above suggestions will be found worth considering. One thing is certain, if the incubator is not afforded proper quarters it can hardly be expected to give good results. The room decided upon, the machine set up, its parts adjusted, and its level taken, it is now in order to clean, trim, and fill the lamp. The wick should be dry-trimmed with a pair of sharp shears before it is inserted in the burner. Then after being passed up and down the tube a few times it should be trimmed again and its corners slightly nicked or rounded. Now is the time to prove whether the burner is in perfect order and that the wick works freely and easily. The wick should now be moistened in kerosene and drawn back to its proper position for lighting. All dust and moisture should be wiped from the burner. Especially important is it that the start be made with a clean tube and sieve. The lamp should be filled within one-fourth of an inch of the top, and then after the burner is attached to the lamp the whole should be cleaned with a dry, clean cloth. The chimney also should be carefully cleaned with a dry cloth. It should be free from dirt, dust, or grease. If the chimney is not kept perfectly clean the lamp will smoke, and a smoky lamp means a poor hatch. Dry cleaning cloths should be set apart for this purpose. All these details looked after, the lamp can be lighted and placed in position if the machine is a hot-air machine; but if it is a hot-water machine the lamp must not be lighted until the tank is filled with water in accordance with the instructions that accompany the machine. Study the structure of your lamp and exercise great care in putting it together as well as cleaning and filling it the first time. Familiarity gained and habits formed will be of value to the operator in the future management. Accuracy and thoroughness are important.

Use nothing but the best grade of oil. No incubator will do good work with poor kerosene. The best will cost less in the end. It will give more heat, less smoke, and make less dirt and less work. If oil is bought by the barrel do not accept it in an old barrel. It may be short in measure or it may contain water and rubbish in the bottom of the barrel.

With the incubator in its place, all parts adjusted, the tank, if any, filled with water, and the lamp lighted and wick turned up so as to give a clear, white flame—just high enough, but not too high—we are ready to balance the machine or to establish the ratio between the thermometer, the regulator, and the lamp.

The incubator should be run with the trays empty for at least twenty-four hours before the eggs are placed in the egg chamber. This gives it a chance to get well warmed throughout, and it also gives the operator time and practice in adjusting the regulator so that it will keep the egg chamber at the proper temperature. This temperature should be exactly 100° F. for several hours before the eggs are put into the egg chamber. All this time the lamp should be kept in order and made to burn with a clear, white flame, so that it does not smoke and so that it can be turned a little either up or down without smoking. This is essential. The blaze must be good from the start and the regulator balanced to a good flame, and this must be done before the eggs go into the egg chamber. It is easier and safer to experiment with the lamp and the regulator when the egg chamber is empty than when the machine is full of eggs. A few hours spent in adjustment will be time saved later on. Nearly every machine is accompanied by a card of directions for operating it, which should be studied and followed.

It is not the province of this article to explain the individual peculiarities of the regulators of different makes, but rather to show what results are to be sought. The damper over the top of the chimney should be kept free from the chimney, say about one-eighth of an inch of space being left between or around the margin of the damper. If you are using a hot-water machine, allowance must be made accordingly and leakage looked for before setting the eggs. The general principle, so far as the regulator and the lamp are concerned, is the same in all machines. At the end of the experimental twenty-four hours, again fill the lamp and trim the wick, and with the machine running steadily at 100° F. the egg tray, loaded according to directions given below, can be placed in the egg chamber. The eggs should be clean and dry and should have been prepared and balanced as suggested in the early part of this article. When filling the trays put in eggs enough to fill completely every space, with every egg lying upon its side. Do not stand the eggs upon end nor pile them one upon another. The filled tray being now placed in the egg chamber, close the door, being careful not to slam it and so disturb the regulator or the lamp. The machine can now be left by itself an hour. At the end of that time visit it, and if the thermometer still stands at 100° leave it again for another hour. At the third visit it may be necessary to turn the regulator thumbscrew, or the wick may need raising or lowering a little. It will be a matter of judgment at first whether you change the wick or the regulator. In most cases, if the blaze is about right, it is best to leave it so and to more completely balance the machine by a slight manipulation of the regulator, for if this is nicely done upon the start the temperature can be controlled during the entire period of incubation by slightly turning the wick. Note the repetition: Have your flame to suit you at the outset, leave it so, and adjust the regulator accordingly.

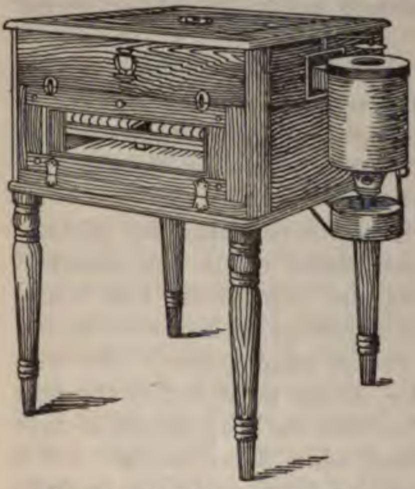
FIG. 11.—A well-made incubator.

It takes twenty-four hours properly to test the lamp and adjust the regulator. During this time the eggs are gradually warming up, and the operator is supposed to be watching the machine and studying his instruction book. If a hot-water machine is used, some allowance must be made for the time occupied in warming the tank, unless it is filled with water already warmed. Let the operator bear in mind that each incubator has its own peculiarities and must be learned and managed accordingly. Another thing to note is that the manufacturer of an incubator is likely to understand its management and the operator is quite safe in following the printed directions for setting up and starting the machine; but, while the manufacturer understands the mechanical details of the construction and adjustment of his goods, his notions about the future management of his or any other machine may not be at all like, nor at all superior to, those of some other manufacturer. This is illustrated in natural incubation.

One farmer sets all his hens in straw nests, another sets them all in chaff nests, another sets them all upon the ground and in earth nests, but the results are about the same. Methods may seem to differ and yet results may be very much alike.

The hatch can now be said to be begun. The incubator has been set up, adjusted, and tested under heat for twenty-four hours. It has been found capable of maintaining an even temperature, and the eggs are already warm in the egg chamber. The thermometer has been placed at a level with the top of an egg near the center of the tray. At first the work will require a few visits at intervals of not more than one hour apart, but after the third of these, if everything seems all right, the machine can be left alone for three or four hours, but the operator should be sure to visit it just before he retires for the night. On the morning of the second day the temperature should have risen to 102° F. It must not be forgotten that from now on the eggs will manifest a little heat of their own and this must be considered, as it will influence the action of the regulator. Or, in other words, if the egg is fertile the germ will begin to waken into life and possess and give off heat. This lessens the work of the lamp and should make the operator cautious in his manipulations of the regulator. The temperature from now on should be kept at 103° F. If the machine is balanced right, a very slight turn of the regulator button or of the wick elevator is all that will be required. The operator must not become overanxious now; he should resist all temptation to tamper unnecessarily. It is better to change the adjustment but a mere trifle and then wait a little to observe the result than to make great and abrupt changes. It is very easy to cook the eggs and quite as easy to chill them. All changes should be gradual, and the machine always be under the control of the operator. Once in good working order, the less an incubator is disturbed the better. From now on it should be visited at regular intervals, three times a day—morning, noon, and night. At the same hour every morning the wick should be trimmed, the chimney cleaned, and the lamp refilled. The visit at noon is simply one of inspection and observation. At this visit the operator should look first at the thermometer and then at the lamp. If the temperature is right and the lamp is burning well, there is nothing more to do.

Returning to the work of the morning after, the lamp is cared for and started again, the operator should watch it carefully for a brief period. Then, if the thermometer shows the proper temperature, it is in order to turn the eggs. During turning the tray should be removed from the egg chamber and the door closed. Some of the details of turning have been given. The hand should be clean and the eggs gently rolled around. It should not require much time to turn the eggs, three or four minutes being sufficient. As a rule no other cooling is necessary, but this subject will be referred to later on. Many devices have been invented for turning the eggs, but the simple method of turning by hand is sufficient. Gently brush or roll them around or change them from one side of the tray to the other. The necessity for turning depends upon the fact that unless the egg is turned, its substance will gravitate, the egg will become too dry upon one side, and the chick will become attached to this dry side. Such an event will result in a dead or deformed chick. The whole process of turning is so simple that further explanation seems unnecessary. As to how frequently they should be turned, once a day is sufficient, though many practice turning twice a day. This turning should be continued from the third until the nineteenth day. After the usual signs of hatching can be heard the eggs must not be moved or disturbed. After the nineteenth day the rule "do not turn them," is imperative. The chick, ready to break its way out, has found its proper position, and to move the egg may so place the chick that it can not work to advantage or that it will drown or smother.

Cooling.—Many successful poultry men pay little attention to cooling the eggs further than to take plenty of time in turning. Much depends upon the machine, and more upon the condition of the atmosphere. If not exposed to draft or sunlight, the eggs can be left outside the machine for fifteen or twenty minutes and be none the worse for the exposure, but, as a rule, an exposure of five minutes is sufficient. That some cooling is necessary seems borne out in natural incubation by the practice of the hen, which leaves her nest from ten to sixty minutes every morning. Of course, the hen may do this for her own accommodation, but it seems to be part of the programme in natural hatching, and better results are obtained when the eggs are cooled somewhat every day. This practice of cooling should be continued to the eighteenth day. Right here it may be well to advise the inexperienced operator to keep the egg chamber closed after the evening of the eighteenth day and until the close of the hatch.

Moisture.—This subject is one upon which opinions differ vastly. In the opinion of the writer much depends upon the incubator, its location, and the external atmosphere. All agree that a certain amount of moisture is needed. In natural incubation the hen leaves her nest early in the morning, while the dew is yet upon the grass, and if caught upon her return to the nest her feathers will be found to be wet. Yet some of the most successful hatches have been made by hens that were not allowed to leave the hatching pen. Hence the argument is not settled. But, from the fact that the early morning atmosphere is damp and the eggs are exposed to this moist atmosphere while the hen is off the nest, it is safe to infer that a limited amount of moisture is essential. If the incubator stands in a damp cellar, a very good hatch can be made without the introduction of any moisture into the egg chamber; while upon the other hand, if the machine is located in a dry room and the weather is dry, a poor hatch can be expected if no moisture is supplied. Many different methods of supplying moisture have been suggested, but most experienced operators incline to the simplest methods. A small sponge saturated with pure water can be placed in the egg chamber and allowed to remain there overnight, or a saucer containing a little water can be placed in the bottom of the egg chamber and left from time to time, or the hand of the operator can be dipped in warm water and brushed lightly over the eggs just before they are returned to the machine in the morning. The last seems to be a natural method and does not overcharge the egg chamber with moisture. Too much moisture will ruin the hatch, and it is better to err upon the side of too little than too much. A good rule is to note the barometer and in damp weather supply very little moisture. As to what is meant by much or little moisture, the writer thinks that a teaspoonful of water is plenty for 100 eggs in wet weather, while in dry weather an ounce is none too much, this being for a period of twenty-four hours. Or, again, if the machine stands in a cellar, a teaspoonful of water will last 100 eggs three days, while in a dry, well-ventilated room a tablespoonful of water every twenty-four hours will do no harm. The water supplied must be clean and pure and should be warm when it is introduced. Surely with these few hints the operator ought to be able to settle the moisture question for himself.

Testing.—The egg will show signs of hatching within thirty hours of its first exposure to heat. Along about the twenty-eighth hour a point denoting the head and another denoting the heart will appear. About the forty-fifth hour the expert can detect a slight motion of the heart. In about seventy hours the membrane known as the allantois is visible. This envelope is the temporary breathing apparatus of the chick. On the fifth day the streaks denoting the limbs can be seen. On the sixth day the liver can be located, and a slight voluntary motion is observable. By the seventh day the lungs, stomach, and brain show development; the eyes can be found by the tenth day; and on the twelfth day feathers begin to form. The bill opens and shuts by the fifteenth day, and the cry of the chick is heard about the eighteenth day. Soon after, or early in the nineteenth day, the chick bursts the air cell at the end of the egg and begins to use its lungs in breathing. From this time it grows rapidly and soon becomes strong enough to break through the shell.

While the process of hatching is very interesting, the practical operator need not concern himself with minute details. The eggs should be tested at least three times during the period of incubation. First, as a matter of economy. Eggs not fertile will not spoil for a few days, and they will be as good for the table or feed after a few days in the incubator as after as many days in the nest. Again, eggs that are doubtful can be cooked for food for young chicks or cooped fowls. Another reason why nonfertile eggs should be discovered and removed is that they absorb some heat from the air of the egg chamber and generate none of their own. Again, if nonfertile eggs happen to be old when placed in the tray they are liable to decompose, and, by giving off poisonous gases, foul the air of the egg chamber and poison the chicks in the good eggs. However, it is not wise to disturb the eggs too frequently. Testing upon the seventh, the tenth, and the fourteenth days is quite sufficient. All nonfertile and all doubtful eggs should be removed from the machine as soon as their condition is detected.

The process of testing is simple enough after a little experience is acquired. It depends upon the appearance of the egg when it is held between the eye and a light. In order that the view may be most advantageous, it must be contrasted with a dark border. Many different egg testers have been devised, but they all depend upon the above principle. The simplest in construction is a plain tube about 1½ inches in diameter and made of tin, wood, or cardboard. The egg is placed snugly against the opening in this tube, and it is so held that the egg is between the tube and the light and the tube is between the egg and the eye. With the eye close to the uncovered end of the tube, a picture of the egg can be seen through the transparent shell. If the test is made in a dark room, a much better view can be obtained. A very fair test can be made in a dark room by holding the egg before a small aperture in a window shade, provided the sun is shining against the window. In cloudy weather, when the sun can not be depended upon, some kind of an egg tester is required. All manufacturers furnish some kind of egg tester with every machine sent out, and the most of them work upon the same principle and are operated in the same way. Evening is the best time for making the test. Have ready a low table and an empty tray, also a basin or a basket. The operator can work best if seated at the table with the lamp in front of him; upon his left is the tray of eggs to be tested, with the empty tray and basin upon his right. Every detail should be arranged before the eggs are removed from the egg chamber, as a prolonged exposure is to be avoided. One by one the eggs are taken from the tray, tested as above suggested, the appearance observed, nd the egg, if fertile, placed in the empty tray, or, if infertile, placed the basket. As soon as all are tested the tray containing the fertile eggs is replaced in the incubator, the door of which is then closed and the machine left as before. Experience soon teaches one the appearance of the nonfertile and the spoiled egg, as contrasted with that of the fertile egg which has already begun to hatch. The fertile, or hatching, egg will show a spiderlike formation, a center with long crooked threads, or rays, leading outward, and this formation will float as the egg is turned, seeming to have an inherent power of motion. Such eggs are good and the germ is alive and hatching. But if this formation is a black stationary spot and the red lines come together in a circle, the egg is one that has been fertile, but the germ of which is now dead. Such an egg should be removed from the tray at once. The egg that remains clear except for a small dark cloud is infertile and may possibly be used in cooking. In case an egg is doubtful it can be marked and returned to the tray and left there a few days to be tested again. All eggs that cool too quickly should be marked for special examination, and remember that the egg that does not contain life will be cooler than the live egg. Cracked eggs can be saved by the use of court plaster, but unless it be from a rare or valuable fowl the attempt to hatch a broken egg will hardly be worth the trouble. At the second testing, about the tenth day, the eggs that are hatching well will be nearly half darkened, while the others will look more or less as they did in the first test. On the seventeenth day the chick will be seen to fill all the egg but the air space, unless it has died in the shell since the previous testing. The final testing should be carefully made and with the shortest possible exposure.

The air cell.—Books upon incubation devote much space to this subject. The writer thinks it cuts but little figure in the work of the operator. If the air cell is too large the egg is too dry, while if not large enough the egg is too moist, and the moisture supply can be governed accordingly. Experience will teach the operator much more about the air space than will written pages, and until he is experienced he need not attach very great importance to it unless it be unusually large or small. By the end of the sixteenth day this occupies about one-fifth of the space in the egg, and the chick ought to occupy the remainder of this space. The air cell gradually increases until the eighteenth day. Upon the eighteenth day, or the nineteenth day at most, the eggs are turned and cooled for the last time. After this do not disturb the eggs. If necessary, partly close the ventilator slide. Leave the door closed. Of course, the thermometer must be watched and the lamp filled and trimmed more carefully than ever. Do not be alarmed if the thermometer shows a temperature of 104° at this time. No harm will be done if the eggs are kept at that temperature a few hours.

The operator is again cautioned to let the eggs alone during the last two days of incubation. If the door must be opened to rearrange the thermometer or to supply moisture, it should be for a brief period only, and great care should be exercised not to jar nor change the positions of the eggs. But the lamp should be kept in good order and the regulator and thermometer watched closely. Some of this has been stated before, but it will bear repeating, for many a good hatching prospect has been blighted by overanxiety or curiosity.

At the end of the twenty-first day open the door and pull the tray partly forward. Then remove the shells and, if any chick is found with the shell dried upon it or in any way attached to it, carefully liberate the chick and place it in the nursery below. Then carefully close the door and let the machine alone for another six hours unless the eggs are all hatched sooner.

The eggs about all hatched, now is the time to clean and set up the brooder, which should be heated a few hours before the chicks are removed from the nursery. After the hatch is completed and the chicks are removed from the nursery, the machine should be taken apart, carefully cleaned, and set right for future use. The brooder should be started at about 98° F. and gradually lowered at the rate of 1° a week, according to the weather and the experience and judgment of the poultry man.

The chicks should not be fed until they are thoroughly dried and have been out of the incubator at least twenty-four hours. The first feed should be fine sharp grit or sand, upon which is sprinkled a very little hard-boiled egg chopped fine. After this they should be fed every three hours a little broken grain or, better yet, some of the excellent prepared dry chick foods upon the market. Clean, fresh water should be supplied from the start. Wet, sloppy food should be avoided. If none of the manufactured chick foods are at hand, a substitute can be made by cracking a mixture of wheat, corn, and egg shells. Any good poultry journal will give valuable hints upon the subject of raising chickens in brooders.

SUMMARY.

Study your incubator.

Acquaint yourself with all its parts.

Read the manufacturer's directions for setting it up.

Set it up carefully and according to instructions.

Never try to run an incubator in a drafty place, nor near a stove, nor where the sun shines upon it.

Set fertile eggs only. Waste no effort upon those that are doubtful.

Learn how to trim and clean a lamp.

Keep the lamps full and the wick and tube clean.

Avoid smoke.

See that the eggs are clean and dry before setting them.

Balance all eggs, large end up, a few hours before placing them in the tray.

Do not overfill the tray.

Turn every egg the third day.

Cool the eggs every morning.

Be sure your hands are clean when handling eggs.

Test all eggs by the seventh day.

Test again by the eleventh day.

Test again by the fifteenth day.

If the air space is too large, supply moisture; if too small, put a saucer of dry lime in the room and run without moisture a day or two.

Do not expect to learn all about the air cell the first hatch. You will learn that later.

Do not disturb the eggs after the evening of the eighteenth day.

Have a regular hour for incubator work.

Do not tinker too much with the regulator.

Get the adjustment right and keep it so.

Heat your machine and make your adjustment before placing the eggs in the egg chamber.

GENERAL REMARKS.

The average farmer, his wife, his son, or his daughter, should not expect to learn all about the management of an incubator from the perusal of written pages. Experience comes from the work itself. This work is easy, interesting, and fascinating. It occupies the mind and leads to investigation. More than that, it leads to success and profit. But great results can not be expected in the beginning. The poultry business is a trade and must be learned. Many a person is idle to-day and looking for some sphere of usefulness who could learn how to operate an incubator to both mental and financial advantage. But the work, slight as it is, must be done properly and at the right time. The poultry business is honorable and profitable, but it requires study and experience. We serve a long and faithful apprenticeship to learn other more laborious and less remunerative trades, when the same amount of application would in less time make us experts with an incubator and give us a trade in a line not affected by strikes or lockouts, or liable to be overcrowded.

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The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

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COOPER MEDICAL COLLEGE
San Francisco, Cal.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 237.

Experiment Station Work,

XXXII.

Compiled from the Publications of the Agricultural Experiment Stations.

LIME AND CLOVER.
PLANT FOOD REQUIREMENTS OF FRUIT TREES.
APPLE GROWING IN NEW YORK.
RUNNING OUT OF SEED WHEAT.
HIGH-PROTEIN SEED WHEAT.
TOBACCO SEED SELECTION.
COVER CROP FOR TOBACCO FIELDS.
CEREAL BREAKFAST FOODS.
DAMAGED WHEAT AS FEED.
BEDDING FOR COWS.
AMATEUR POULTRY RAISING.
CARE OF CREAM ON THE FARM.
PAYING THE PATRONS OF CREAMERIES.
GASSY FERMENTATION OF SWISS CHEESE.
YEAST AS A DISINFECTANT.

PREPARED IN THE OFFICE OF EXPERIMENT STATIONS.
A. C. TRUE, Director.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

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Iowa—*Ames:* C. F. Curtiss.[a]
Kansas—*Manhattan:* J. T. Willard.[a]
Kentucky—*Lexington:* M. A. Scovell.[a]
Louisiana—
  State Station: *Baton Rouge.*
  Sugar Station: *Audubon Park, New Orleans.*
  North Louisiana Station: *Calhoun;* W. R. Dodson.[a]
Maine—*Orono:* C. D. Woods.[a]
Maryland—*College Park:* H. J. Patterson.[a]
Massachusetts—*Amherst:* W. P. Brooks.[d]
Michigan—*Agricultural College:* C. D. Smith.[a]
Minnesota—*St. Anthony Park, St. Paul:* W. M. Liggett.[a]
Mississippi—*Agricultural College:* W. L. Hutchinson.[a]
Missouri—
  College Station: *Columbia;* H. J. Waters.[a]
  Fruit Station: *Mountain Grove;* P. Evans.[a]
Montana—*Bozeman:* F. B. Linfield.[a]
Nebraska—*Lincoln:* E. A. Burnett.[a]
Nevada—*Reno:* N. E. Wilson.[d]
New Hampshire—*Durham:* W. D. Gibbs.[a]
New Jersey—*New Brunswick:* E. B. Voorhees.[a]
New Mexico—*Mesilla Park:* L. Foster.[a]
New York—
  State Station: *Geneva;* W. H. Jordan.[a]
  Cornell Station: *Ithaca;* L. H. Bailey.[a]
North Carolina—*Raleigh:* B. W. Kilgore.[a]
North Dakota—*Agricultural College:* J. H. Worst.[a]
Ohio—*Wooster:* C. E. Thorne.[a]
Oklahoma—*Stillwater:* J. Fields.[a]
Oregon—*Corvallis:* J. Withycombe.[a]
Pennsylvania—*State College:* H. P. Armsby.[a]
Porto Rico—*Mayaguez:* D. W. May.[c]
Rhode Island—*Kingston:* H. J. Wheeler.[a]
South Carolina—*Clemson College:* J. N. Harper.[a]
South Dakota—*Brookings:* J. W. Wilson.[a]
Tennessee—*Knoxville:* H. A. Morgan.[a]
Texas—*College Station:* John A. Craig.[a]
Utah—*Logan:* P. A. Yoder.[a]
Vermont—*Burlington:* J. L. Hills.[a]
Virginia—*Blacksburg:* A. M. Soule.[a]
Washington—*Pullman:* E. A. Bryan.[a]
West Virginia—*Morgantown:* J. H. Stewart.[a]
Wisconsin—*Madison:* W. A. Henry.[a]
Wyoming—*Laramie:* B. C. Buffum.[a]

[a] Director. [b] Assistant director. [c] Special agent in charge. [d] Acting director.

EXPERIMENT STATION WORK.

Edited by W. H. Beal and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far hey will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. True, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.[a]

LIME AND CLOVER.[b]

arious explanations have been offered for the soil condition wn as clover "sickness," or the failure of soils, otherwise protive, to yield good crops of clover; and it is doubtless true that ous causes do contribute to this result, but that in many cases ay be due simply to an acid condition of the soil, which can be lily corrected by the judicious application of lime, the character he growth of clover furnishing a very good means of determining ther lime is needed, is very clearly shown in experiments recently rted by C. E. Thorne, of the Ohio Station.

r a number of years it has been increasingly difficult to secure a crop of r on the experiment station farm. The seed germinates and at first the d appears to be good, but when the wheat is taken off the growth of clover und to be uneven, there being patches of good clover interspersed with s on which the plants are stunted. These areas increase in size as the on progresses. The clover on them is largely destroyed during the winter wing the seeding, and by spring there is usually but little clover left.

his difficulty is not confined to the station farm, but is prevalent over a iderable part of northeastern Ohio. The soil on which this trouble is experced is generally found to give an acid reaction under the litmus test, and poorer the clover the more pronounced is the indication of acidity.

ere is an evident relation between the previous treatment of the soil and present behavior of clover upon it. Land which has been brought under vation at a comparatively recent date, or which has been kept in good t by liberal and frequent use of manure in a well-planned crop rotation, ill producing fine crops of clover; but on lands which have been steadily ped for half a century or more, with little manuring and a rotation of s in which clover was grown but once in five or six years, and especially hose which have been stimulated to unusual production of cereals by the use cid phosphate, without reenforcement by materials carrying nitrogen and ssium, there is a general and increasing failure of the clover crop. * * *

n the soil of the main station, naturally somewhat deficient in lime because ts origin, the condition unfavorable to clover is aggravated by the use of ilizing materials originally compounded with acid, such as acid phosphate, ssium chlorid, and ammonium sulphate, although these materials are by

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A progress record of experimental inquiries, published without assumption of onsibility by the Department for the correctness of the facts and conclus reported by the stations.

Compiled from Ohio Sta. Bul. 159.

no means the sole cause of this condition. On this soil a luxuriant growth of clover has been secured by the use of lime, in conjunction with materials carrying both phosphorus and potassium. Lime alone, though increasing the growth of clover somewhat, does not produce a full yield, nor does such a yield follow the use of lime in association with a carrier of phosphorus only, or of potassium only. When the lime has been applied to the corn crop two years before the clover seed was sown, the corn being followed by oats and wheat the effect on the clover has been much better than when the lime was applied to the wheat crop the fall before sowing the clover seed.

Experiments made at other stations, especially the Rhode Island Station,[a] have indicated that the detection of an acid condition was a sufficient index of the need of liming. This conclusion is not entirely borne out by the experiments of the Ohio Station, since although all three of the soils experimented with were acid, only two of them were benefited by liming. The behavior of clover on the different soils, however, was very characteristic. The growth on the soil which did not respond to liming was normal, while on the other two soils it was small and irregular until lime was applied.

Until we have more definite knowledge in this direction, therefore, we would recommend a careful study of the clover crop as an index to the need of any particular soil for liming, rather than exclusive dependence on the test for acidity, although that also should be employed.[b]

When the common red clover, after taking root in the spring, is found later in the season to be making no growth, and finally disappears in patches or altogether, then the need of lime is indicated. This condition of the soil is usually found in regions where the natural supplies of lime are scanty, the soils having been derived from sandstones or shales, and the small stores of lime reduced by long-continued cropping. The appearance of the plant known as sorrel, or horse sorrel (*Rumex acetosella*), is a further indication of the need of lime. Usually this plant first appears on the higher and poorer portions of the field, and as it becomes more abundant it gives to these portions the peculiar color from which it derives its name. Such soils are usually found to give an acid reaction to the litmus test.

There are, however, other soils which may be improved by liming. Heavy refractory clays, difficult to plow and breaking up into clods requiring much labor to pulverize, and producing a uniform and healthy appearing but small and unsatisfactory growth of clover, followed by equally unsatisfactory yields of other crops, may be completely changed in character by a large dressing of lime, the lime opening them up to the action of the weather and putting them in such condition that clover will grow luxuriantly. And where clover attains its normal growth any other crop ordinarily cultivated in Ohio may be successfully grown. This is to say, not that the growing of clover will dispense with the use of manures or fertilizers, but that a luxuriant clover crop will leave the soil in such physical condition that manures and fertilizers will produce their full effect upon subsequent crops, and that it will supply a large part of the nitrogen required by one or two cereal crops following. But it must be remembered that clover provides only nitrogen from sources outside the soil itself, and that it really facilitates the exhaustion of the soil stores of phosphorus, potassium, and lime, so that if soil fertility is to be maintained without impairment these stores must be replenished by fertilizing or manuring.

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[a] U. S. Dept. Agr., Farmers' Bul. 133, p. 6.

[b] For means of detecting and correcting soil acidity and determining and supplying the lime requirements of soils, consult also U. S. Dept. Agr., Farmers' Bul. 77.

PLANT FOOD REQUIREMENTS OF BEARING FRUIT TREES.[a]

The amount of plant food which mature fruit trees in the full vigor of bearing use in one growing season has recently been reported by L. L. Van Slyke, O. M. Taylor, and W. H. Andrews, of the New York State Station. From one to three standard varieties were examined in each case. With each variety the fruit, leaves, and new growth of wood, as represented by the extension of the branches during the season, were gathered, dried, and analyzed. The fruit on the different trees was picked when ripe. The foliage was left until it showed a tendency to drop. The twigs of new wood were removed soon afterwards.

The apple trees in the experiment yielded during the season from 23 to nearly 30 bushels of fruit each, the peach trees from nearly 3 to over 4 bushels each, the pears from 1 to 5 bushels each, the plums from 1 to 1.75 bushels each, and the quince tree about 1.5 bushels. The following table shows the average amount of plant food used by each fruit tree of the different varieties studied:

Plant food used during a season's growth by a mature fruit tree in full bearing.

Variety.	Nitrogen.	Phosphoric acid.	Potash.	Lime.	Magnesia.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Apple	1.47	0.39	1.57	1.62	0.66
Peach	.62	.15	.60	.95	.29
Pear	.25	.06	.27	.32	.09
Plum	.25	.07	.32	.34	.11
Quince	.19	.06	.24	.27	.08

The above table shows the total amount of plant food used by the fruit, leaves, and wood of each kind of tree in one growing season. The figures might be considerably different with smaller younger trees, or larger older trees, or with trees not in bearing.

If the table is carefully examined it will be seen that—

the relative proportions of the different plant-food constituents are approximately the same for the different varieties of fruit trees. This means that, under like conditions of soil fertility, a mixture of nitrogen, phosphoric acid, and potash which would meet the requirements of one variety would also meet the needs of the other varieties, so far as the supply of these plant-food constituents is concerned. What particular proportions are best adapted to meet the needs of any particular soil can be determined only by special experiment.

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[a] Compiled from New York State Sta. Bul. 265.

Using the above table as a basis, the amount of plant food used per acre by the different fruits can be easily determined. The following table shows the data thus deduced:

Plant food used per acre by different fruit trees and by wheat.

Variety.	Number of trees per acre.	Nitrogen.	Phosphoric acid.	Potash.	Lime.	Magnesia
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds*
Apple	35	51.5	14.0	55.0	57.0	21.0
Peach	120	74.5	18.0	72.0	114.0	25.0
Pear	120	29.5	7.0	33.0	38.0	11.0
Plum	120	29.5	8.5	38.0	41.0	12.0
Quince	240	45.5	15.5	57.0	65.5	19.0
Wheat	[a] 20	39.5	12.0	16.2	....	....

[a] Bushels.

This table shows that "peach trees used the largest amounts of plant food; apple and quince trees, approximately alike in the results given, come second, while pear and plum trees, which give results much alike, come third."

The amount of plant food used by a crop of wheat yielding 20 bushels of grain and a ton of straw per acre is included in the table for comparison. It can be readily seen that a heavy crop of fruit uses much more plant food during the growing season than a crop of wheat. If, therefore, it is considered necessary to fertilize the soil to secure a crop of 20 bushels of wheat per acre, it would seem even more necessary to fertilize for a crop of fruit.

The table shows further that—

> the amounts of nitrogen and potash used by any one kind of fruit trees were approximately the same in most cases, while the amount of phosphoric acid was only about one-fourth the nitrogen or potash. In most commercial fertilizers used on fruit trees the phosphoric acid is present in proportions about 4 times the nitrogen. This is on the assumption that the soil contains more nitrogen relatively than phosphoric acid, which may or may not be true in individual cases. The question may be raised as to whether quantities of phosphoric acid are not frequently applied much in excess of the actual need of a season's crops.

PRACTICAL APPLE GROWING IN NEW YORK.[a]

The claim is sometimes made that the experiments conducted at the stations are often on so small a scale that practical farmers do not have faith in them, and that greater weight would be attached to the results if the experiments and observations were on a much larger scale or were carried out under such conditions as confront the farmer himself. Of unusual interest, therefore, from this standpoint, is the work recently reported by G. F. Warren, of the New York Cornell Station, in which he gives the results of his examination of 1,138 apple orchards, covering 8,642 acres, in Wayne and Orleans counties, N. Y. Both of these counties are extensive apple-growing regions. In one township every orchard as large as an acre in extent was visited. Observations were made on such factors as location, site, aspect, soil, management, distance between trees, pruning, present condition of the orchard, orchard troubles, etc.

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[a] Compiled from New York Cornell Sta. Buls. 226, 229.

In Wayne County Mr. Warren found the average yield for four years of 31 orchards, which had been tilled five years or more, to be at the rate of 266 bushels per acre. Thirty-five orchards which had been tilled most years averaged 229 bushels per acre. Forty-two orchards in sod most years, but occasionally tilled, yielded an average of 202 bushels per acre. Forty orchards which had been in sod more than five years yielded only 148 bushels per acre. These figures show an increased yield for orchards tilled five years or more of about 80 per cent over orchards which had been five years or more in sod.

This greater yield in the tilled orchards was found not to be due entirely to cultivation, since the man who took the trouble to till his orchard usually gave the orchard better care as regards fertilizers, spraying, pruning, etc. Considering, therefore, only orchards which were well cared for, the orchards tilled five years or more still gave about 35 per cent better yields than the orchards which had been five years in sod.

Many of the sod orchards examined were pastured with cattle, sheep, or hogs. The yield in 1902 of 22 orchards pastured with hogs was 271 bushels per acre; of 15 orchards pastured with sheep, 216 bushels per acre; of 54 orchards pastured with cattle, 159 bushels per acre; and of 47 orchards not pastured, 185 bushels per acre. It is thus seen that hogs were least and cattle most injurious in the orchard. Pasturing the orchard with either sheep or hogs, however, resulted in better yields than not pasturing.

About 30 per cent of the orchards examined in Wayne County were not fertilized; 60 per cent received barnyard manure, and a few orchards also received some commercial fertilizer and green manure. The average yield for the two years, 1902 and 1903, of 220 fertilized orchards was at the rate of 257 bushels per acre, and of 78 unfertilized orchards, 202 bushels per acre. This represents an increased yield of 55 bushels per acre for the fertilized orchards.

Relative to the value of spraying 66 sprayed orchards, representing 626 acres, yielded in 1903 at the rate of 280 bushels per acre, while 107 unsprayed orchards, covering 673 acres, yielded at the rate of 253 bushels per acre. The amount received for 8,430 barrels of sprayed apples averaged $2.02 per barrel, while 6,365 barrels of unsprayed apples brought but $1.80 per barrel.

The following data, secured in Orleans County, show the yield and income from well-cared-for orchards sprayed different numbers of times in 1904:

Yield and income from orchards sprayed different numbers of times.

How treated.	Yields.			Portion of crop barreled.	Incomes.		
	No. of orchards.	No. of acres.	Average yield per acre.		No. of orchards.	No. of acres.	Average income per acre.
			Bushels.	*Per cent.*			
Unsprayed	43	381.0	328	66	54	449.5	$108
Sprayed once	33	352.0	346	74	30	316.0	139
Sprayed twice	70	701.0	374	78	64	644.0	143
Sprayed three times	27	247.5	414	87	25	236.5	184
Sprayed four times	6	43.0	569	77	6	43.0	211

The effect of distance between trees set before 1880 was studied in its relation to yield. The following four-year averages were found:

	Bushels per acre.
Trees not over 30 by 30 feet apart	186
Trees 31 by 31 to 35 by 35 feet apart	222
Trees 36 by 36 to 40 by 40 feet apart	229

Among other matters noted in the survey, drainage was deemed desirable in 54 orchards in one township. The yield of these 54 orchards in 1902 was at the rate of 203 bushels per acre, or 42 bushels per acre less than the average of orchards in the township. The four-year average yield of orchards on elevated sites in this same township was at the rate of 227 bushels per acre; on moderate and slightly elevated sights, 224 bushels, and on low sites 213 bushels per acre. "Evidently the site is not a very important factor. The best site is, doubtless, one that is sufficiently elevated to give good opportunity for air and water drainage, but not so high as to be sharply exposed to wind."

The kind of soil on which the orchard is located was not found of so much importance as the kind of treatment the soil received. Good crops were found growing on quite diversified soils. A well-drained deep loam is recommended.

The effect of renting orchards was well brought out in the data secured. The survey showed that 77 per cent of the orchards in Wayne County were managed by the owners, and 23 per cent by renters. The four-year average yield of orchards managed by the owners was at the rate of 210 bushels per acre, while in the orchards managed by renters the average yield was 174 bushels per acre.

This survey, covering as it does the actual practices of farmers in two of the most important fruit-growing counties of New York, and giving the actual results in yields and income by different methods of treatment in hundreds of orchards, is on a sufficiently large scale to make the results obtained of more than usual value and interest. It is gratifying to find that the cultural methods long recommended by the experiment stations as a result of trials on a small scale hold true when applied to orcharding on a commercial scale.

RUNNING OUT OF SEED WHEAT.[b]

T. L. Lyon and Alvin Keyser, of the Nebraska Station, report experiments to determine what basis there is for the prevalent belief among farmers, grain dealers, and millers that a change of seed wheat from time to time is very desirable and that the productive power and quantity of grain deteriorate when it is grown continuously in the same locality.

In the experiment reported, seed obtained originally from Kansas and Iowa in 1899 has since that time been grown at the Nebraska Station with Nebraska-grown seed. A like comparison has been made since 1902 between western and central Kansas, Ohio, Iowa, and Nebraska grown seed.

The experiments resulted as follows:

> Seed wheat brought from a distance did not in any case prove as good as the locally grown seed of the same variety. Locally grown Turkish Red yielded better than imported Crimean for each of the three years tested. * * * Turkish Red seed brought from western Kansas yielded nearly as well as the Nebraska-grown seed and was of better quality during the drier years, but suffered more from scab or blight in 1903 and 1904.

These results are a notable addition to the rapidly accumulating evidence that locally developed seed is the most reliable and that individual farmers should give more attention to the production of their own seed. The bringing of high-priced high-bred seed from a distance—however valuable the seed may be under the conditions of soil, climate, etc., under which it was produced—is more than likely to prove a disappointment under the changed environment. The best seed for any locality is that wisely selected and carefully bred under the conditions peculiar to that locality.

SELECTION OF SEED WHEAT WITH HIGH PROTEIN CONTENT.[b]

Investigations are reported by J. N. Harper and A. M. Peter, of the Kentucky Experiment Station, which show that the hard flinty wheat kernels are the richest in protein. Flinty wheats, however, tend to become softer when grown year after year without selection. It is necessary, therefore, if the flinty character and high protein content are to be maintained, that seed should be carefully selected each year. It was found by examining the kernels from a large number

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[a] Compiled from Nebraska Sta. Bul. 89.

[b] Compiled from Kentucky Sta. Bul. 113.

of different heads of wheat that there was very little difference in the physical appearance of the individual kernels composing any one head except in respect to size, and that the grains from the several heads of any one stool were sensibly alike. The grains from different stools, however, often differed materially, some being flinty, others starchy. The larger kernels in the center of a head were richer in protein than the smaller kernels near the base and tip. The earlier varieties were found to be richer in protein than the later varieties. It is recommended that flinty kernels from the middle of the head of early varieties (if equally good in other respects) should be selected for planting in order to develop a high protein type of wheat. Such wheats are preferable, both from the baker's standpoint and from the standpoint of value as food. A simple machine to test the relative hardness of kernels by measuring the pressure required to cut them transversely has been devised by the station.

TOBACCO SEED SELECTION.[a]

In bulletins of the Connecticut State and Maryland stations A. D. Shamel and W. W. Cobey, of the Bureau of Plant Industry of this Department, point out the necessity for careful selection of seed plants, prevention of cross fertilization, and sorting of seed, in order to secure more uniform and better quality tobacco. The Maryland Station bulletin gives the following concise directions for procuring good tobacco seed:

(1) Save the best plants in the field for seed plants. During the cultivation of the crop and the suckering and topping processes a constant search for good plants should be made by growers.

(2) When good plants are observed, they should be plainly marked by a tag or rag tied to the plant, so that they may be easily found and to prevent them from being accidentally topped.

(3) Place a 12-pound manila paper bag over the flower heads of the selected seed plants before the first flowers open. Inspect the bags every few days for the first two weeks and raise them up farther on the growing stems, arranging them so as to prevent any injury from crowding in the bag during this period of growth.

(4) At the end of the season, when the seed pods are ripe, cut off the plants near the ground without removing the bags and hang them up in a dry place. The bags serve to catch the seed which may fall out of the capsules in drying.

(5) After the seed has thoroughly dried, shell it out of the capsules and separate out the heavy seed for use.

According to A. D. Shamel, as explained in the Yearbook of this Department for 1904[b]—

The most satisfactory means of separating the light from the heavy seed is by using a current of air. A simple and effective device for the purpose is shown in figure 1. The material necessary for constructing this machine can be obtained by tobacco growers from almost any chemical supply house. The foot bellows (*a*) is connected by means of a rubber tube (*b*) to the valve tube (*c*). The glass tube (*d*) is fitted with a rubber cork (*e*), in which the valve tube is inserted. The top of the cork is covered with a piece of finely woven gauze, in order to prevent the seeds from entering the valve tube. About an ounce of seed for separation is placed in the glass tube, and a current of air is injected by means of the foot bellows. The strength of this current must be regulated by the valve (*c*), so that only the dirt, chaff, and light seed will be blown out of the top of the tube. It is advisable to screen out all of the large particles of hulls and trash before putting the seed in the tube.

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[a] Compiled from Connecticut State Sta. Bul. 150; Maryland Sta. Bul. 103; U. S. Dept. Agr., Yearbook 1904, p. 435.

[b] See also U. S. Dept. Agr., Farmers' Bul. 225, p. 10.

It is claimed to be easily within the reach of every tobacco grower to select his seed plants in the manner outlined, and to thereby improve his crop without any extra expense and very little labor. "The increase in yield of corn and wheat which has resulted from careful seed selection and breeding is sufficient evidence of the possibility of securing a like improvement in the tobacco crop through similar methods."

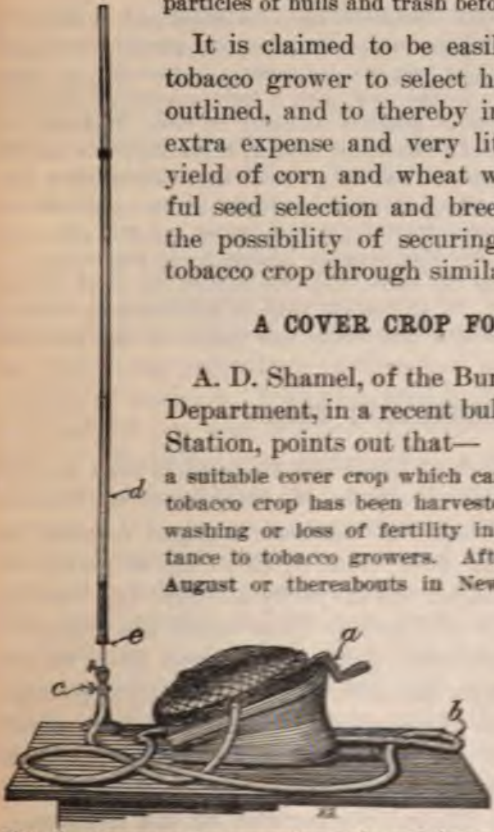

FIG. 1.—Apparatus for separating light and heavy seed of tobacco.

A COVER CROP FOR TOBACCO FIELDS.[a]

A. D. Shamel, of the Bureau of Plant Industry of this Department, in a recent bulletin of the Connecticut State Station, points out that—

> a suitable cover crop which can be sowed immediately after the tobacco crop has been harvested, so as to protect the soil from washing or loss of fertility in other ways, is of special importance to tobacco growers. After tobacco has been harvested, in August or thereabouts in New England, there is a considerable loss of plant food from the soil—lying bare for nearly nine months—by leaching and drifting of the surface soil; and the heavy fall and spring rains on sloping land may badly wash and gully the fields.

A number of different kinds of cover crops, including rye, various clovers and other legumes, etc., have been used, but none has proved entirely satisfactory. Recent experiments, however, indicate that a crop well suited for this purpose is found in hairy or Russian vetch. "It has a peculiar habit of growth, and when sowed alone the plants spread out on the surface of the ground, covering it completely with a dense matted growth." The fact that the vetch is a nitrogen gatherer makes it of special value for many tobacco soils which are relatively poor in nitrogen.

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[a] Compiled from Connecticut State Sta. Bul. 148.

Russian vetch requires moisture during the first few weeks of growth, but after it becomes established is one of the best drought-resisting forage plants grown. The plant withstands cold, heat, and drought, but does not do well where water stands in the soil or covers the land. It has very fine small roots, which penetrate the soil in every direction, and when the plants are turned under they rapidly decay and give up their plant food to the succeeding crop. * * *

Owing to the large size of the seed—about the size of a small pea—a stand is easily secured in the fall, and when sowed at this time the plants will cover the ground before cold weather. The best way of seeding is probably to plow the land and broadcast, harrowing in the seed with a light smoothing harrow. If it is to be sowed with the greatest possible economy of seed, it should be planted in drills 2 to 4 feet apart and cultivated several times until the plants cover the ground. The seed should be sowed as soon as possible after the tobacco is cut, and at the rate of about 1½ bushels of seed per acre broadcast. When sowed in drills, probably from three-fourths to 1 bushel per acre will suffice. The best time for sowing is probably between August 1 and September 15.

When planted on land which has not borne this crop before, the seed should be inoculated before sowing, * * * or the soil may be inoculated by sowing on it, with the seed, surface soil from a field where this vetch has been recently and successfully grown.

CEREAL BREAKFAST FOODS.[a]

The number and variety of cereal breakfast foods at present on the market is large, but as pointed out by L. H. Merrill, of the Maine Agricultural Experiment Station, who has been engaged recently in a study of the digestibility and food value of this class of goods, in cooperation with this Department, the majority of them fall readily into three groups. The first would include those which are prepared by simply grinding the decorticated grain, the second those which have been steamed or otherwise partially cooked and then ground or rolled, and the third those preparations which have been acted upon by malt, which induces a greater or less chemical change in the starch present. The earliest of the cereal breakfast foods which came into general use in the United States were of the first class, oats being the most commonly eaten. Coarsely ground uncooked wheat does not seem to have been so generally used for preparing a breakfast dish, though corn meal and hominy have long been and still are popular. As the use of cereal breakfast foods became more common, the raw products were to a considerable extent replaced by the so-called rolled oats and wheats constituting the second group, and these goods are commonly conceded to surpass the simpler old-fashioned raw products in ease of preparation in the household and in other ways. The manufacturers claim that the malted and otherwise specially prepared goods of the third class represent a still further advance.

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[a] Compiled from Maine Sta. Bul. 118. See also Maine Sta. Buls. 55 and 84 for earlier work by C. D. Woods and L. H. Merrill.

In the manufacture of the malted goods barley malt is mixed with the cereal under conditions favorable to the action of the ferment present, the result being that some of the cereal starch is converted into a soluble form.

Some of the malted and other cereal foods are fully cooked, as by parching in addition to steaming, and may be eaten dry without further preparation, or, as many prefer, with the addition of cream and sugar. In a few cases the manufacturers cater still further to the popular taste by wetting the cereal with a salted or sweetened solution, after which it is again dried and slightly browned.

As regards composition, the figures published by Professor Merrill show that, as is obvious indeed from their appearance, the cereal breakfast foods are comparatively dry products, the average moisture content of the different sorts of corn, wheat, and oat products included in his comparison being not far from 9 or 10 per cent. Rolled oats, which he selected as a basis for comparison in his discussion, has the following percentage composition as shown by the average of a number of analyses: Water 8.4, protein 15.6, fat 7.5, carbohydrates 66.6, and ash 1.9 per cent, the heat of combustion being 4.323 calories per gram. The rolled oats contained considerably more protein, fat, and ash than rolled wheat, corn meal, or hominy, and also furnished more energy. It is, however, surpassed by the corn and wheat products as sources of carbohydrates. It should be remembered that corn in its natural condition contains on an average about 4 per cent fat. The small amount, 0.7 per cent, found on an average in the corn meal and hominy analyzed is due to the removal of the germ in milling. The malted products examined were more thoroughly dried than the other goods, containing only about 7 per cent water. Otherwise their percentage composition did not vary greatly from that of the corresponding unmalted cereals.

> Analyses made at different times of the same brand [of cereal breakfast foods] show great variations in composition. This is not strange when it is remembered that there are many varieties of these cereal grains varying much in composition, and that even the same variety will show wide differences in composition according to the character of the season and of the soil and fertilizer used.

A number of digestion experiments were made in which rolled oats, rolled wheat, granulated corn meal, hominy, and some of the common commercial brands of specially prepared breakfast foods were studied. The ready-to-eat goods were used as manufactured. The rolled oats and wheat were cooked for forty-five minutes in a double boiler. In general, about 90 per cent or over of the organic matter was retained in the body when the cereals were eaten with a mixed diet containing bread and meat, with a simple diet of cereal, cream, and sugar, and also when the results were computed for the cereal breakfast food alone. In the case of the mixed diet the highest percentage of digestible protein, 93.2, was noticed with the rolled wheat ration, and the lowest, 88.9 per cent, with hominy. In case of the simple diet, the range in digestible protein was from 82.3 per cent with granulated corn meal to 91.6 per cent with the rolled wheat ration. Considering the results for the cereal breakfast foods alone, the lowest value, 57.7 per cent digestible protein, was noted with a specially prepared whole-wheat product, and the highest value, 85 per cent, with rolled oats. The available energy was high in all cases. It was not far from 95 to 97 per cent with the mixed diet. With the simple diet the range was somewhat greater, namely, 91.1 per cent with a specially malted cereal to 96.4 per cent with hominy. With cereals alone the lowest value was 84.1 per cent available energy with a specially prepared whole wheat cereal, and the highest value, 94.4 per cent, with hominy.

According to the author corn products with a mixed diet and with a simple diet made a favorable showing as regards both total organic matter and energy, but were inferior to the other goods in respect to the digestibility of protein.

If the value of the cereal breakfast foods be based upon the digestibility of the protein when the foods are used with a mixed diet, rolled wheat must be placed first and corn products last. When the digestibility of the cereals alone is considered, rolled wheat ranks first, not only in digestibility of the total organic matter, but also with respect to the protein. The rolled oats rank next, and the corn preparations and the specially prepared whole-wheat product the lowest of all.

Treating the cereals with malt at the factory increases somewhat the amount of dextrinized starch present and, according to the manufacturers' claims, increases digestibility, but, as pointed out by Professor Merrill, cooking also renders starch soluble and "we may conclude, therefore, that the dextrinization of these goods by the manufacturers is in itself of little importance so far as the digestibility of the food is concerned, unless the preparations are to be eaten without further cooking. * * * The housewife finds a material gain in time in the use of cooked or partially cooked cereals."

The importance of thorough cooking is emphasized, and an hour at least is recommended, in the case of hominies and old-fashioned oatmeals; and though it is asserted that the rolled cereal products may be prepared in ten to twenty minutes, in most cases it will be found advisable, according to the author, to cook them for a longer time.

In a study of cereal breakfast foods reported by Harry Snyder,[a] of the Minnesota Experiment Station, the difficulty commonly experienced in digesting imperfectly cooked oatmeal is attributable to the large amounts of glutinous material which surround the starch grains and prevent their disintegration. When thoroughly cooked the protecting action of the mucilaginous protein material is overcome, and the compound starch granules are sufficiently disintegrated to allow the digestive juices to act.

The increased digestibility of the thoroughly cooked cereal, Professor Snyder believes, is largely due to a physical change in the carbohydrates, which renders them more susceptible to the action of digestive juices.

In connection with the Maine investigations the importance of the ash constituents of cereal breakfast foods is discussed. The advocates of the extended use of cereal breakfast foods lay much stress upon the large amount of mineral constituents (lime, phosphorus, and iron) which they are said to contain as compared with white flour.

> The oat and wheat breakfast foods contain from 1.5 to 2 per cent of ash constituents; graham flour carries an equally large amount, while patent flour contains only about one-half of 1 per cent. Hence it is said that we should eat the coarser flours; or if we persist in eating bread of patent flour, we should supplement our diet by the use of cereal breakfast foods. If there is any force in this argument it lies in these two assumptions: First, that white flour, as now milled, no longer contains enough ash constituents to satisfy the needs of the body. Second, that bread flour and the cereal breakfast foods are the only sources from which the body may derive mineral matters. In point of fact, an average diet, even though it does not include coarse flour and cereal breakfast foods, probably carries the mineral salts in quantities largely in excess of our needs.

In general, the author concludes that—

> while the modern methods of milling cereal breakfast foods have changed the mechanical condition of the cereal, and in many cases the form of the carbohydrates as well, yet the actual nutritive value is for the most part a characteristic of the cereal itself, and is changed but little by its method of preparation. * * *
>
> It has been claimed that cooked or partially cooked cereals possess superior keeping qualities. If this be true, it is probably due to the sterilizing effect of the heat employed in their preparation and the greater dryness of the product. * * *
>
> The investigations made at [the Maine] station have thus far failed to discover any fixed relation between price and nutritive value. It is only fair to add, however, that, whatever the relative food values of malted and unmalted foods, the cost of the former to the manufacturer is greater, and the increased price is to this extent justified.

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[a] Minnesota Sta. Bul. 74.

process of maturing and not hastened to maturity, as in case of rusted wheat, for example.

In experiments made in Canada frozen wheat gave a return of about 60 cents per bushel when fed to steers, and from 45 to 75 cents per bushel to pigs, depending upon the way it was fed. The best results were obtained when the grain was ground or soaked for twenty-four hours before feeding. Both the beef and the pork produced was of superior quality. In experiments at the Utah Station frozen wheat was compared with good wheat and wheat screenings as a feed for sheep. The animals made profitable gains on all three feeds, the screenings (containing alfalfa and clover seed, cracked and shrunken wheat, etc.) giving somewhat better results than either frozen wheat or good wheat.

According to J. W. Wilson, of the South Dakota Station, a considerable amount of wheat in the northwestern part of the United States was damaged by rust in 1904 and its value lessened for milling purposes. In comparative tests of the feeding value for pigs of two lots of such damaged wheat weighing, respectively, 57 and 44 pounds per bushel, he found that rating pork at 4 cents a pound the heavier wheat gave a return of 63 cents, the lighter 57, per bushel. The heavier wheat contained 13.21 per cent of protein and the lighter 12.01 per cent, and practically the same amount of carbohydrates, 72 per cent. The heavier wheat was not only a richer feed, but was apparently more digestible than the lighter.

While no careful experiments on the subject are recorded, the indications are that many of the damaged wheats are, as a rule, somewhat less digestible than normal wheat on account of their poor physical condition, which prevents thorough mastication. In order, therefore, to get the full benefit of such feeds they should be ground or thoroughly soaked, or both ground and soaked before use. The Canadian experiments indicate that unground or cracked grain should be soaked forty-two hours, and that ground grain is improved by soaking at least twelve hours. As already indicated, the wheat should not be fed alone, but gives best results when fed in connection with other grain feeds or mill products, such as bran, or with succulent root crops. At the Canada Experimental Farms pigs were fed as much ground frozen wheat as they would eat up clean, in connection with as much skim milk as they would drink, with excellent results both as regards rate and profitableness of gain and quality of pork produced.

BEDDING FOR COWS.[a]

Wheat straw is quite generally and satisfactorily used as bedding material for cows where dairying is carried on in connection with eneral farming. Where dairying, however, is the principal indus-y of a farm the supply of wheat straw is likely to be deficient and e question of securing bedding material becomes then and occa-onally at other times an important problem. To gain information s to the value of various substitutes for wheat straw was the object f experimental work conducted recently by C. F. Doane at the Mary-nd Experiment Station.

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[a] Compiled from Maryland Sta. Bul. 104.

While bedding material for cows should be as free as possible from ust and dirt that might get into the milk, should not irritate the kin of the animals, and should conform to other requirements, wo very important considerations—those studied by Doane—are the eeping of animals clean and the power of absorbing liquid manure.

The cutting of wheat straw did not result in a saving of bedding aterial, as even with a much larger quantity of the cut straw the ows were not so clean. As indicated by the experiments, 2,300 ounds of cut straw or 1,800 pounds of uncut straw would be re-uired per cow yearly in order to keep animals equally clean.

Cut corn stover was compared with whole wheat straw. About ne-third more, by weight, of the stover was required to accomplish he same purpose as the straw. The stover, nevertheless, was consid-red a more desirable bedding material than the straw, and where heat is grown primarily for the purpose of securing straw for bed-ling it is believed that corn stover might be economically substituted o a considerable extent.

Sawdust was found the most satisfactory of the bedding materials ested. Unfortunately, it is not always available, and objections, oreover, have been made to sawdust manure. Shavings were found o be almost equally as good as sawdust; but the same objections ave been raised to shavings manure as to sawdust manure. The ests indicated that about 1,100 pounds of shavings would be required early per cow. "For the strictly sanitary dairy, sawdust or shav-ngs are the ideal bedding materials, though the ordinary dairy armer could not be advised to buy when he could raise either the traw or the stover."

The absorption tests were made in the laboratory, and judging from the amount of water capable of being absorbed by each of the aterials used, it was estimated that 2.8 pounds of cut stover, 3.3 pounds of wheat straw, 8.3 pounds of sawdust, or 3 pounds of shav-ngs would be required to absorb the liquid manure produced by one ow in sixteen hours. The yearly cost of bedding at local prices was stimated at $2.55 for cut stover, $3.11 for wheat straw, $0.30 for saw-ust, and $3.28 for shavings where cows are stabled sixteen hours per ay, or $3.65, $4.15, $0.45, and $4.81, respectively, where the cows are tabled the entire time.

SAWDUST AND SHAVINGS MANURE.

The relative value of the manure produced with different litters was not studied in the experiments reported by the Maryland Station. There is a widespread belief, apparently not without some foundation in fact, that shavings and sawdust manure is inferior in several respects to straw manure. The principal objections which have been raised to sawdust and shavings manure are that (1) it is poorer in fertilizing constituents than manure made with straw, for example, because straw is itself richer in fertilizing constituents than sawdust. Litters in general are, as a rule, poorer in fertilizing constituents than the manure (solid and liquid) with which they are mixed, and therefore tend to dilute it and lower the percentage content of fertilizing constituents of the final product. Not only is sawdust poorer in fertilizing constituents than straw, but more of it is required than of straw to absorb the liquid manure. Shavings apparently have greater absorbtive power than sawdust. (2) Shavings and sawdust decompose much more slowly in the manure heap and in the soil than straw and similar litters. It is claimed, therefore, that on this account manure containing shavings and sawdust is so light and open in the heap as to be likely to ferment improperly and is very slowly converted into humus in the soil. While, therefore, definite experiments furnishing positive evidence bearing on the various objections enumerated are limited, it seems safe to conclude that sawdust and shavings manure is, as a rule, somewhat less valuable ton for ton than straw manure made under like conditions and requires to be handled and applied with more care, especially in case of heavy manuring on light dry soils.

SUGGESTIONS FOR AMATEUR POULTRY RAISERS.[a]

In a recent bulletin of the Connecticut Storrs Station, C. K. Graham makes a number of suggestions of value to the many people who raise a few chickens for their own use or for the local market, but not enough to justify them in investing the money necessary to equip a model poultry plant. The following is a summary of these suggestions:

SELECTION AND HANDLING OF EGGS FOR HATCHING.

Much depends upon the selection of eggs for hatching. Eggs for this purpose should be of uniform shape and size and thickness of shell. Rough-shelled, dirty, and mottled eggs with thin shells should be excluded. "There is some doubt as to the advisability of setting small eggs. While it is possible that they may be as fertile and produce as many chicks as larger eggs, it is probable that pullets from the former will have a tendency to lay small eggs;" small eggs should, therefore, be avoided.

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[a] Compiled from Connecticut Storrs Sta. Bul. 36.

Eggs which are over five days old should not be used. "Every egg should be carefully dated when taken from the nest in order to avoid error on this point. While good hatches have been secured from eggs that were three weeks old when placed in the incubator, as a rule they can not be expected to hatch well after they are ten days old."

In shipping eggs for hatching too much care can not be taken in packing.

An ordinary basket with plenty of excelsior in the bottom and the sides well cushioned makes an excellent receptacle. Into this the eggs, carefully wrapped, should be packed, and over them plenty of padding placed. Cheese cloth or cotton tacked over the top forms a satisfactory covering. Such a package, conspicuously labled "Eggs for hatching," can be shipped any distance and will reach its destination in good condition. Upon receipt of the package the eggs should not be removed until the hen or incubator is ready to receive them, but the [eggs] should be turned over daily.

BROODING HENS.

"Almost any broody hen can be made to sit if carefully handled. She should not be carried by the legs with her head hanging down, but with her breast resting in the palm of the hand. Transfer should be made at night, and the nest into which she is put kept dark for twenty-four or thirty-six hours." The hen should be kept free from lice.

REARING INCUBATOR CHICKS BY BROODY HENS.

"A hen to which incubator chicks are to be given should be free from lice and in a nest where other hens can not disturb her. In the evening 2 or 3 chicks, at least thirty-six hours old, may be placed under her from behind, care being taken not to excite her, lest she step on them. At least one chick of each color should be given her, for hens are apt to kill chickens of another breed, color, or size than those they have already adopted. The following morning she may be expected to mother as many as are given her.

"The first week is the most critical period in the life of the chick. Trouble is most likely to be caused by chills." Coops should be used which do not permit the chickens during this period to get away from the mother. Later they should be removed to a slat coop which allows them free range. It is not advisable, however, to allow the hen free range for at least two weeks.

If she is kept confined and fed coarse grains, while the chicks are being fed a few yards away on finer grains, she will soon forget to call them and probably will start to lay in three or four weeks, and at the same time will con protect the chicks during nights and unpleasant weather. If the chick be distributed among several hens, it will be advisable to make colon being taken to put those of about the same age together. Chicks of ages should not be fed together, since the smaller ones will be crowd the grain and will not thrive.

REARING CHICKS WITH BROODERS.

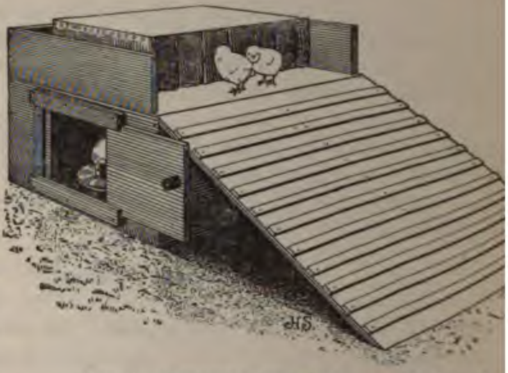

FIG. 2.—General view of home-made brooder

Those who prefer the artificial method of raising chicks car a brooder out of an old packing case which will accommod chicks, at a cost of about a dollar. Such a brooder has given lent results at the station when used in a shed or colony house. Details of construction of a brooder of this kind are shown in figures 2 and 3. The lower section of the brooder, which contains the lamp for heating, is a box 3 feet square made of 10-inch boards, which is covered with tin or galvanized iron. Above this cover, around the edges of the box, 1-inch strips are nailed. Two 1-inch holes are bored th these strips on each side of the box for the purpose of ventilatio floor of matched boards is laid on the strips. A hole 8 inc diameter is cut in the center of this floor and over it is rever old tin pan 10 inches in diameter, the sides of the pan being pu full of holes low free circu of heat. Ove is placed a t feet 6 inches s with legs 4½ high. Aroun sides of this t tacked a curtain of felt cut from top to bottom at intervals of inches to allow the chicks to pass in and out at will, the whole surrounded by boards 4 inches high and 3 feet long nailed to at the corners and resting on the floor of the brooder. Wh chicks are 10 days old one of these boards may be taken away bridge used so that the chicks may run from the hover to the fl the room (see fig. 2).

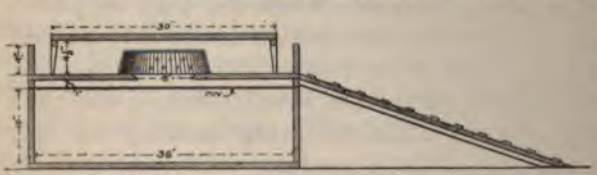

FIG. 3.—Section through middle of home-made brooder, showing details of construction.

A good brooder accommodating from 25 to 50 chickens can be bought of almost any incubator firm for from $12 to $16.

CARE OF YOUNG CHICKS.

In order to have a good, early maturing pullet it is necessary that she get a good start. The first few weeks' care is responsible to a great extent for her success or failure eight months later. Feed, regularity of feeding, cleanliness, and plenty of grit and water are all important matters. Chicks should be carefully protected from storms and sudden changes of weather, since these, together with the low vitality of the parent, are responsible for more deaths than is improper food. Poultrymen differ considerably as to when the chick shall have its first food. Good results have been secured when chicks have been permitted to pick a little sand or fine grit from a clean board when about 36 hours old, and, when about 48 hours old, to eat bread crumbs moistened in milk and squeezed dry. After that almost any of the prepared chick foods may be fed about five times a day till the chicks are 2 or 3 weeks old, when they will do well on wheat screenings and need not be fed oftener than three times a day. It is advisable to let the chicks have access to green feed at all times. Fine clover hay, cut with an ordinary straw cutter, is excellent, and also makes a good litter to scatter the feed in. It is best, however, to give the last food at night on a clean board, letting the chicks eat all they will and then removing the board. At other times care should be taken that they be kept hungry, or at least sufficiently so to be eager to eat when fresh food is offered them.

CARE OF CREAM ON THE FARM.[a]

In a recent bulletin of the Wisconsin Station discussing a number of creamery problems, E. H. Farrington makes some statements regarding the care of cream on the farm which are of special interest "to the creamery operator and dairy farmer in sections where farm separators have been introduced for separating the cream from milk." Attention is called to the fact that "these machines are now comparatively new to many of the farmers, and the change from daily delivery of whole milk to sending cream once or twice a week has made considerable difference in the methods of handling the milk and cream at the farms."

The problem of caring for the cream so that it may be delivered to the creamery in good condition is a serious one, because it has an important bearing on the quality of the butter. In many cases butter made from cream not properly cared for does not sell for the top market price, and since there is a growing tendency to sell butter on its merits, giving only the price its quality deserves, there will be difficulty in disposing of butter made from a poorer quality of farm separator cream at prices equal to those of butter made at whole-milk creameries. Considering the question, however, from the mechanical side of the butter-making process alone, there is no good reason why farm separator cream should not be equal to, if not better than, that separated at a factory with power separators.

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[a] Compiled from Wisconsin Sta. Bul. 129.

When milk is separated at the farm immediately after milking, the cleanest and sweetest cream possible ought to be obtained; it certainly should be better than that skimmed by a factory separator from milk which is 2 to 20 hours old, and on this account a better butter should be made from the farm separator cream.

The usual causes of defective butter from gathered cream are: First, unsuitable places for keeping the cream, and, second, holding the cream too long before it is collected by the cream gatherers. A perfectly clean, sweet, and satisfactory cream is produced on many farms in the State and delivered in good condition to either a retailer, an ice-cream maker, or a creamery. There are, however, places where tainted and defective cream is found, and in some cases it is being mixed with cream of a better grade. This is hardly fair to the producer of first-grade cream, and in order to raise the standard of the entire product to a grade equal to the best the following suggestions are offered as a guide to persons not familiar with proper methods of caring for cream:

(1) Place the separator on a firm foundation in a clean, well-ventilated room where it is free from all offensive odors.

(2) Thoroughly clean the separator after each skimming. The bowl should be taken apart and washed, together with all the tinware, every time the separator is used. If allowed to stand for even one hour without cleaning there is danger of contaminating the next lot of cream from the sour bowl. This applies to all kinds of cream separators.

(3) Wash the separator bowl and all tinware with cold water and then with warm water, using a brush to polish the surface and clean out the seams and cracks; finally scald with boiling water, leaving the parts of the bowl and tinware to dry in some place where they will be protected from dust. Do not wipe the bowl and tinware with a cloth or drying towel; heat them so hot with steam or boiling water that wiping is unnecessary.

(4) Rinse the milk-receiving can and separator bowl with a quart or two of hot water just before running milk into the separator.

(5) Cool the cream as it comes from the separator or immediately after to a temperature near 50° F. and keep it cold until delivered.

(6) Never mix warm and cold cream or sweet and slightly tainted cream.

(7) Provide a covered and clean water tank for holding the cream cans, and change the water frequently in the tank so that the temperature does not rise above 60° F. A satisfactory arrangement may be made by allowing running water to flow through the cream tank to the stock-watering tank.

(8) Skim the milk immediately after each milking, as it is more work to save the milk and separate once a day and less satisfactory than skimming while the milk is warm, since the milk must be heated again when saved until another milking.

(9) A rich cream testing 35 per cent fat or more is the most satisfactory to both farmer and factory. The best separators will skim a rich cream as efficiently as a thin cream and more skim milk is left on the farm when a rich cream is sold.

(10) Cream should be perfectly sweet, containing no lumps or clots when sampled and delivered to the haulers or parties buying it.

There is a good demand for sweet cream and it can easily be supplied by keeping the separator, tinware, strainer cloth, and water tank clean, and the cream cold. The preceding recommendations when followed will pay well for what some may think is "a lot of extra bother."

PAYING THE PATRONS OF CREAMERIES.[a]

The amount of butter fat in milk or cream as determined by the well-known Babcock test has become generally adopted in this country as a basis for calculating dividends at creameries. Where a creamery is supplied with milk alone or with cream alone the problem presented is a simple one, but where both milk and cream are received at the same creamery and are not kept separate in the making of butter, the problem is somewhat more difficult, and as indicated by recent publications of the experiment stations, is not always satisfactorily solved.

One patron brings milk to the creamery, where it is tested and separated. He then takes away the skim milk containing a certain amount of butter fat which it is impossible to remove by the separator. Nevertheless he is credited with the whole amount of butter fat in the whole milk, although he carries away in the skim milk probably 3 per cent of what he brings. Another patron brings cream to the creamery, where the amount of butter fat it contains is also determined. In this case the patron receives no skim milk and hence takes away no butter fat. It is all used by the creamery. In combining the cream from the milk patron and the cream from the cream patron and dividing the proceeds on the basis of the butter fat supplied by each, it seems obvious that a deduction of 3 per cent should be made from the amount of butter fat in the whole milk of the milk patron or that a corresponding addition of 3 per cent should be made to the butter fat in the cream of the cream patron. The following illustration of the calculation of dividends under these conditions is taken, in substance, from an article by E. H. Farrington in a report of the Wisconsin Station.

Assuming that 125 pounds of butter are sold by a factory for $30, and that the factory receives 4 cents per pound for making the butter, which will amount to $5, this leaves $25 to be paid to the patrons A, B, and C, who supplied the following weights of milk and cream: A, 1,000 pounds of milk testing 4 per cent; B, 1,200 pounds of milk testing 3.8 per cent; and C, 100 pounds of cream testing 16.3 per cent.

The weight of butter fat from the cream patron should be increased by 3 per cent, and patron C, who delivered 16.3 pounds butter fat as cream, should accordingly have this 16.3 multiplied by 1.03, which gives 16.8 pounds.

The weights of fat from which each patron's share of the receipts are calculated will be: A, 40 pounds; B, 43.2 pounds; C, 16.8 pounds; or a total of 100 pounds fat, for which $25 was received. From this we find that 1 pound of fat is worth 25 cents.

The amount due each patron is then found by multiplying his weight of fat by this price per pound, and in this case we would have the following: A, 40 pounds fat, at 25 cents, $10; B, 43.2 pounds fat, at 25 cents, $10.80; C, 16.8 pounds fat, at 25 cents, $4.20.

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[a] Compiled from Vermont Sta. Bul. 100; Wisconsin Sta. Bul. 129, and Rpt. 1900, p. 90

In calculating the dividends of cream patrons when both milk and cream patrons come to one factory the weight of butter fat, found by testing the cream, is therefore multiplied by 1.03, and this result is taken as the total amount of fat delivered by the cream patron.

In a recent bulletin of the Vermont Station J. L. Hills discusses this subject, and gives rules for calculating payments and also simple and concrete examples. Butter weighs considerably more than the butter fat in the milk or cream from which it is made. The difference, known as the surplus or overrun, is greater in creameries receiving only cream from patrons than in creameries receiving only milk. The surplus or overrun in the cream-supplied creamery may be 2.5 to 5 per cent greater than that in the milk-supplied creamery. "A great deal of careful comparison and study has shown that in the long run the excess of surplus arising from the making of butter from the average gathered hand-separator cream, as compared with the manufacture of butter from average delivered milk, approximates 3 per cent." One method of calculating payments given in the Vermont bulletin is based upon the division of the surplus so that the cream patron shall receive 3 per cent more than the milk patron. It is advised that each creamery establish, if practicable, its own factor by periodical test churnings, and use that in preference to the 3 per cent factor, which represents an average. With this explanation the following rules may be given for dividing the surplus equitably between the two classes of patrons and making payments accordingly. The rules as well as the illustrations are taken with some changes in form from the Vermont bulletin.

To determine the milk-fat surplus (or the surplus due the milk patron) and the cream-fat surplus (or the surplus due the cream patron)—

(1) Multiply the pounds of cream fat by the adjustment factor, expressed decimally (i. e., 0.03, 0.025, 0.038). (2) Subtract the result from the total pounds of butter made from both milk and cream. (3) Subtract the total pounds of fat (milk fat and cream fat) from the result obtained in 2. (4) Divide the result obtained in 3 by the total pounds of fat (milk fat and cream fat). This gives milk-fat surplus expressed decimally. (5) Add adjustment factor, expressed decimally, to result obtained in 4. This gives cream-fat surplus expressed decimally.

A simple example:

Pounds of milk received 2,500, test 4 per cent	pounds fat	100
Pounds of cream received 571, test 35 per cent	do	200
Total fat received	pounds	300
Total butter made	do	345

From 100 pounds fat received as milk and 200 pounds fat gathered as cream 345 pounds of butter were made. The 3 per cent adjustment factor is held to be applicable. If 1 pound of fat from cream made 3 per cent more butter than did 1 pound of fat from milk, then the 200 pounds of fat which were gathered as cream made 200 × 0.03, or 6 pounds more butter than would have been the case had these 200 pounds fat been bought as milk. Hence 339 pounds (345—6) represents the weight of butter which would have been made had all the fat been bought as milk, since by use of the adjustment factor the effect of the cream purchase on the surplus has been eliminated.

339—300=39 pounds true milk surplus.
39÷300=13, or 13 per cent true milk surplus, and
13+3=16, or 16 per cent true cream surplus.

To determine the amount of butter made from the milk fat multiply the number of pounds of fat by 1 plus the surplus expressed decimally. In the example given this would be 100×1.13=113. To determine the amount of butter made from the cream fat multiply the number of pounds of fat by 1 plus the surplus expressed decimally. In the example this would be 200×1.16=232. To determine the amount due each patron multiply the number of pounds of butter thus obtained by the price per pound.

Another method of reaching practically the same results where the patrons are paid on the basis of butter fat may be outlined as follows: Determine the surplus due each class of patrons as above. Determine the price per pound of butter fat to be paid the milk patron and the price per pound of butter fat to be paid the cream patron by decreasing the average price on the one hand and increasing it on the other in proportion to the surpluses expressed decimally. This difference is usually about one-half cent per pound.

GASSY FERMENTATION OF SWISS CHEESE.[a]

The manufacture of Swiss cheese is rapidly growing in the United States, and has already become an important factor in regions where special attention is given to cheese making, as in Wisconsin.

The industry is handicapped, however, more or less by serious losses due to abnormal fermentations. These are, as a rule, a consequence of careless methods, and result in defective cheeses.

In a recent bulletin of the Wisconsin Station H. L. Russell and E. G. Hastings report the results of a study of the causes of an outbreak of gassy fermentation of an unusual nature in Swiss cheese, which was the cause of serious loss in a factory in that State, due to the defective cheeses produced.

The defective condition here referred to does not appear while the milk is being worked up into cheese, nor immediately after they are taken from the press. The first abnormal condition is generally noted in the brine tank. When placed therein the cheese do not seem to absorb salt in the usual way, this condition doubtless being due to the absence of those [illegible] changes which are associated with the breaking down of the casein. The first most evident symptom of trouble usually appears when the cheese have been on the shelves for a week or so. The edge of the cheese cracks or opens, generally near the junction of the top or bottom and the side. (See figs. 4 and 5.) This split continues to increase in length, running around the circumference of the cheese, and in severe cases the interior of the curd may be forced out through this crack.

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[a] Compiled from Wisconsin Sta. Bul. 1[illegible]

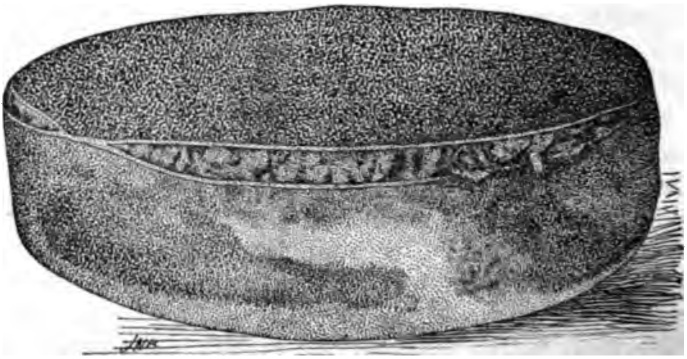

FIG. 4.—Side view of drum Swiss cheese, showing cracking of cheese at edge.

In figure 6 this stretching of the plastic curd toward this opening is well shown. This is of course due to the pressure of gas within the cheese. Relief from this pressure occurs at this point because resistance is less here than elsewhere.

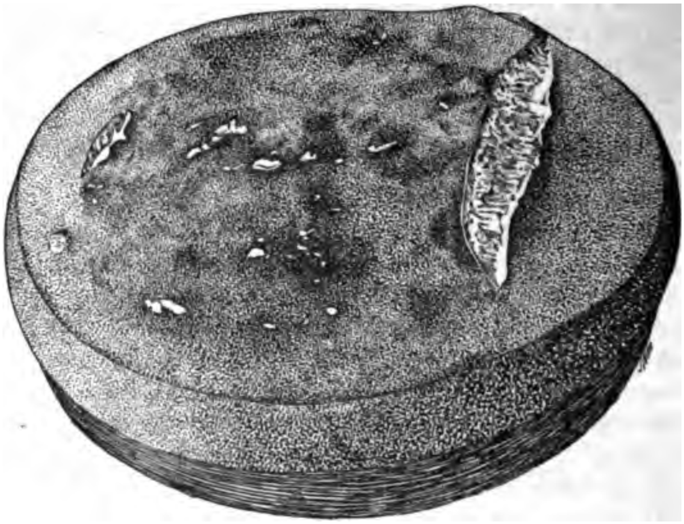

FIG. 5.—Top view of drum Swiss cheese, showing rupture of surface at several different points.

Sometimes the cheese " huff " without splitting in this way, but generally they do not show marked evidence from the outside. Usually the cheese have a poor texture, remain tough and rubbery, even when of considerable age. When a plug is drawn or the cheese is cut, the gaseous fermentation is usually very evident. The texture shows abundant gas holes of varying size. These are always more numerous than are to be found in a normal No. 1 Swiss. Some-

mes cheese are found that split open on the edge and still show a solid body. ı all cases, however, the flavor is decidedly off, a disagreeable sweet taste eing observed. The affected cheese are also usually off in color. Very gassy heese are badly bleached. Neither do the cheese seem to have the usual egree of acidity.

Investigation showed that the abnormal fermentation was due to ıe presence of yeast cells which in some unknown way had gained ccess to the milk and had passed into the cheese.

The trouble appears to be largely due to the factory methods and pecially to the way the whey is handled.

Where the whey is held for twenty-four hours to allow it to sour, so as to rmit the butter fat to be more thoroughly skimmed, yeast organisms of this pe are almost sure to develop in greater or less numbers. * * * If the utter fat left in the whey after the curd is taken out could be removed immeditely or within a short time, no such development as this could take place. uch can be done by immediate separation of the whey in a cream separator. * * The quality of the butter is enough better and the quantity secured ough larger to warrant the installation of machinery which will do this work. f course, the installation of steam to furnish power could not economically be ade in the smaller factories, but such a course would doubtless prove advangeous in the long run in the factories where a larger amount of milk is andled. The present custom of souring the whey is not nearly as satisfactory om this point of view as the now pretty generally discarded method of scaldg the whey to get the butter fat.

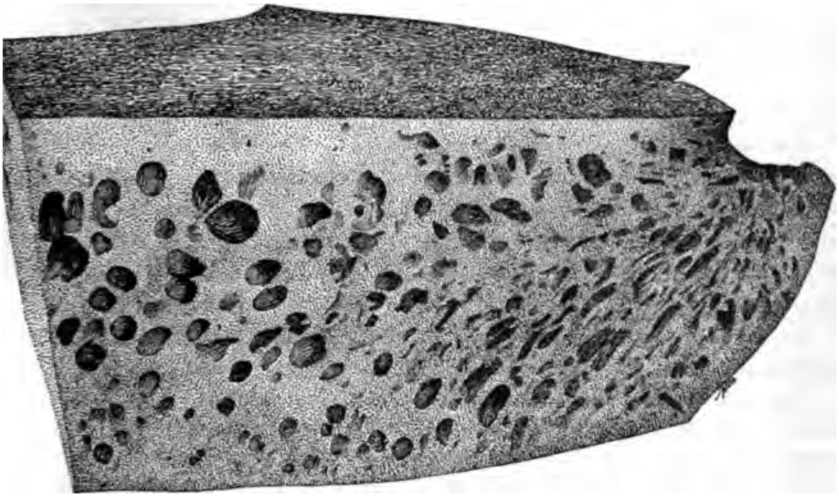

Fig. 6.—Section of affected cheese, showing the crack at junction of side and top.

The practice of soaking whole rennets in whey without boiling or eating the latter is condemned. The use of commercial rennet exracts is considered preferable. "If whole rennets are employed, ated whey should be used, and particular care should be given to he rennet jars, which should receive a thorough sterilization at frequent intervals.

"The quicker the whey can be delivered to the farmers the less likely are troubles of this sort to develop." Special pains should be taken to keep the receptacles clean in which the whey is stored. "Dangers from this source would be entirely eliminated if a different receptacle than the can used for the fresh milk was employed to carry back the whey to the farm. Old, discarded cans that are not fit to use for the milk could be utilized for this purpose."

When a factory once becomes badly infected thorough disinfection is necessary. Heat is naturally the most effective agent for destroying the germ.

> If steam is at hand, even a momentary exposure is sufficient to destroy its vitality, but where reliance is had only on a scalding temperature (150° F.) it is necessary to prolong the period of exposure for at least ten or fifteen minutes. For washing the walls and floors of a factory a 2 per cent solution of hot lye will prove effective.

YEAST AS A DISINFECTANT.[a]

The use of yeast to destroy disease-producing bacteria has been recently proposed, and the treatment has attracted much attention on account of its simplicity, the harmless (nonpoisonous) character of the material used, and its apparent effectiveness. Trials made by the veterinarian of the Nebraska Station, A. T. Peters, indicate that the treatment will prove of value in veterinary practice.

The preparation of the yeast solution and its use is thus described by Doctor Peters:

> Take one cake of either compressed or dried yeast, add enough water to moisten the same; then allow it to stand at least twelve hours, or preferably twenty-four hours. To this is then added a pint to a pint and a half of lukewarm water. This is used as the cleansing fluid. This treatment is especially promising in case of cows suffering from abortion. The animal to be disinfected is first washed out with lukewarm water, and after being thoroughly cleansed the disinfecting fluid is applied. The same method is pursued in the bull. This treatment is being tried on barren cows also. Knowing that the vagina of barren cows is exceedingly acid, it is hoped to overcome this acidity by repeated injections of fermented yeast germs before service.

The theory is that the acidity of the generative organs is due to bacterial activity, and that yeast solutions introduced as suggested invade all parts of the organs and destroy the bacteria which produce the acid condition.

The value of the treatment for disinfection of wounds and for use internally is also being investigated. The exact value and applicability of the method, as well as its mode of action, have not yet been fully worked out, but the investigations thus far made indicate that it is well worthy of careful trial.

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[a] Compiled from Nebraska Sta. Rpt. 1905, p. 10.

San Francisco, Cal.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 238.

CITRUS FRUIT GROWING IN THE GULF STATES.

BY

P. H. ROLFS,

Pathologist in Charge of Subtropical Laboratory, Vegetable Pathological and Physiological Investigations, Bureau of Plant Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1906.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief,
Washington, D. C., October 20, 1905.

Sir: Many requests are received at the Department of Agriculture for information on the methods employed in growing oranges and other citrus fruits, and it is important that the Department be able to supply the desired information as fully as possible. In order to furnish this information in concise form, Prof. P. H. Rolfs, Pathologist in charge of the Subtropical Laboratory, Vegetable Pathological and Physiological Investigations, Bureau of Plant Industry, has prepared this bulletin on "Citrus Fruit Growing in the Gulf States," which will be of service, it is believed, to many prospective citrus growers and to very many planters now engaged in the industry. I have the honor to recommend that the paper be published as a Farmers' Bulletin.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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CITRUS FRUIT GROWING IN THE GULF STATES.

INTRODUCTION.

The following pages were written for the purpose of giving brief and concise directions for the production of a citrus orchard, the necessity for such a bulletin being apparent from the numerous letters asking for information on this subject received by the Department of Agriculture. It has been the aim of the writer to furnish information to meet the needs of many inquirers rather than to prepare a complete treatise on this industry.

The growing of the finest citrus fruits is a horticultural accomplishment not surpassed in any line of the art. There are very few agricultural occupations that require an equal amount of judgment, and very few that give as remunerative a return for the mental outlay. Everyone who is willing to pay the price, either in labor or in dollars, can grow oranges and grapefruit, but only he who is so constituted as to derive pleasure in exercising his mental faculties to their fullest extent can produce fruit of the finest quality. There is a very long series of conditions, from the choice of the stock into which the bud is to be placed to the delivery of the package of perfect fruit to the consumer, which must be met successfully. If any one of these links in the chain is broken, first place can not be attained. Good judgment with previous knowledge must be exercised in the choice of the stock, the bud, the soil, and the location of the orchard, in the cultivation and fertilization of the crop, in the treatment of fungous and insect diseases,[a] in picking and packing the fruit, and in selecting a market for its disposal.

The production of the finest oranges requires years of most careful study and as diligent attention as the most intricate business operation.

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[a] Fungous and insect diseases, however, are not here discussed, since to treat them adequately would unduly increase the size of this bulletin. For an account of insect enemies, see Farmers' Bulletin No. 172, "Scale Insects and Mites on Citrus Trees."

Unless the citrus grower is in full sympathy with his surroundings and in love with his work, he will as surely fail to produce the best results as would be the case in any other occupation.

CLIMATE.

In general it may be stated that in all regions in which the temperature does not fall below 18° above zero nor rise above 100° F., and where there is sufficient moisture, citrus fruits may be produced. There are, however, localities within these limitations that can not be said to be good citrus-growing sections. In some places, although the trees grow luxuriantly, heavy rainfalls occur at the time when the fruits are maturing, making it impossible to gather and market them. In others the conditions for vegetative growth are so favorable that very little fruit sets. Regions that are excessively dry may, however, be utilized for citrus culture when irrigation can be practiced. The more nearly the northern limit of the citrus belt is approached, the more sprightly and deliciously flavored the fruit becomes, some of the very best fruit being marketed from areas where the trees every winter are in danger of being frozen out.

The ideal climate for citrus growing is one in which the rainfall occurs after the fruit has been shipped and before the new crop begins to ripen. The rainfall should not be excessive, certainly not more than 50 to 70 inches annually, and the winter temperature should not go below 26° to 27° F. of continued cold, though a lower temperature may be withstood for an hour or more without killing the trees. Orange trees in a thoroughly dormant condition can withstand a temperature as low as 24° F. if this is not continued for more than a few hours at a time. A very sharp turn to 18° F., if for only a few hours, will entirely defoliate trees in the most dormant condition, while it is likely to kill the larger proportion of those in active growth. Small trees under 8 to 10 feet high, with poorly protected trunks, are very apt to be cut to the ground under these conditions. Sometimes snow falls and remains on the trees for some hours without seriously damaging orange trees; but this is of rare occurrence.

SOIL.

It will be shown under the heading "Varieties" that citrus trees are exceedingly variable, and consequently will readily adapt themselves to almost any kind of soil in which plants can grow. Varieties of citrus grow upon the sticky, adobe soils of Mesopotamia, upon the alluvial soils of the lower Mississippi, upon the fertile soils of the West India islands, upon the dry soils of Arizona and California, and upon the poor, sandy soils of Florida. There is probably no other genus of fruit trees in which the species are so plastic as to adapt themselves to almost every possible gradation of soil. It should not be inferred, however, that every variety of the genus can be grown upon all of these different kinds of soil, for it is absolutely necessary to choose the particular variety which is adapted to any peculiar soil.

While the rich, alluvial soils produce citrus trees of rank growth which often bear enormous crops of fruit, the finest and highest priced fruits are produced upon the nearly sterile soils. In fertile soils the plant food is seldom properly balanced and present in the condition best suited for producing the finest fruits, nor is it possible to influence the contents or quality of the fruit by applying different forms of chemical fertilizers. If, therefore, a field is normally sufficiently fertile to produce a citrus crop for an indefinite number of years, it is usually impossible to influence the quality of fruit markedly by means of fertilizers. Upon soils which are nearly sterile, however, trees may be started and fed with just such chemicals as will produce the finest quality of fruit. It therefore happens that soils which formerly were considered absolutely worthless for agricultural purposes are now made to produce large crops of most excellent fruit.

SITE OF THE GROVE.

Immediately upon deciding that one wishes to plant a grove he should select the best site that can be procured. A great many questions arise in determining where a grove shall be located. A few of these are discussed below.

DISTANCE FROM TRANSPORTATION LINE.

The ultimate object being the selling of fruit at a remunerative figure, it becomes necessary to locate a grove within a reasonable distance of some line of railroad or water transportation. The distance which it will be profitable to transport fruit by wagon will depend largely on the condition of the roads.

Another determining factor in the matter is the cost of the land. Even a grove of moderate-sized trees should produce a thousand boxes of oranges to the acre. Allowing 50 boxes to a load, this would require 20 trips to the transportation station. If a grove were located 3 miles away from the station, it would probably take one man with a two-horse team six days to haul this fruit. If located one-half that distance, it would require only three or four days. Allowing about $4 a day for this work, the hauling of the fruit from the more distant grove would increase the cost about $8 per acre, which amount must be charged against the original cost of the land. From this the intending purchaser can readily calculate how much more he can afford to pay proportionally for land in close proximity to the railroad station.

CHARACTER OF THE SOIL.

The variation of the soils in the West Indies and in Louisiana, Mississippi, and California is not so sharply marked as that in Florida. There are, however, characteristic soils in each of these regions that are better than others. In all sections a soil must be chosen that is not underlain with a heavy substratum known as "hardpan." The land should be elevated sufficiently to permit free drainage, and, in the sections where irrigation must be practiced, should be so located that water can be easily supplied.

In Florida the soil usually known as hammock land is preferable for orange growing. This, however, is of limited extent and frequently is so far removed from transportation lines that it is not profitable to use it. The second grade is called piney woods land. Groves properly located on this type of soil and managed by intelligent superintendents frequently give the very best returns. It is upon this land that most of the orange groves are located. The cabbage palmetto hammock, if sufficiently high to permit natural drainage, also makes excellent land for citrus growing.

FROST PROTECTION.

After determining that the desirable features specified are to be found in the location under consideration, it is very important to see that the land is well protected from the occasional frosts which visit the citrus-growing sections. Frost protection is imparted by large bodies of water, such as make citrus growing in Louisiana and Mississippi possible, and in Florida near the lakes in the central part of the State, along the Indian River on the east coast, and on Tampa Bay. In the West Indies and the southernmost part of Florida this factor does not enter into consideration. In fact, it seems that those places in the West Indies which are subjected to the lowest winter temperature produce citrus fruits of the highest excellence. The temperature in the vicinity of Mandeville, Jamaica, is said to go as low as into the fifties during winter nights, and yet this is probably the best citrus fruit section on the island.

PROTECTION FROM HIGH WINDS.

A location chosen so as to combine all the qualifications already mentioned may still be undesirable if it is exposed to the force of high winds, which may occur in any portion of the country. It is quite impossible to protect a grove against tropical hurricanes, but the more common high winds of annual occurrence must be considered. They carry off the moisture and bring with them a dry, parching air which is injurious to citrus trees, and they are also very likely to cause "thorning" or to mutilate the fruit in other ways. Sometimes it becomes necessary to erect artificial wind-breaks for protecting a grove not well located. These artificial wind-breaks may later be supplanted by some natural growth that can withstand the force of the wind.

RAINFALL.

The amount of rainfall needed to produce a crop of citrus fruits depends on various factors; prominent among them are character of soil and humidity of atmosphere. Where there is a deficiency of moisture it may be supplied by irrigation, but a superabundance of moisture can be controlled only in a measure by drainage. In the humid portions of the United States and in the rainy sections of the West Indies heavy rainfalls frequently occur at the time when the fruit should be marketed or when the trees should be dormant preparatory to blooming. As these conditions can not be corrected, citrus orchards should never be planted in regions where fall or winter rains are prevalent. This is especially true of the rainy side of most islands in the West Indies group.

VARIETIES.

The group of plants which is designated by the generic term "Citrus" is fairly well circumscribed, but when it comes to a segregation of the different species and varieties scientists do not all agree. While it may be of interest to the scientific plant breeder to know just what the classification is, to the practical grower of fruits who wishes to get a large return for his labor it makes very little difference whether the product belongs to one variety or another. The results of the various attempts to classify the plants which fall under the general term "Citrus" vary exceedingly, and various differing opinions regarding their scientific relations are held by scientific investigators. There are therefore a number of different classifications. In the following table the writer has adopted the classification worked out by Dr. Herbert J. Webber in the Cyclopedia of American Horticulture.

BOTANICAL AND HORTICULTURAL CLASSES OF THE GENUS CITRUS.

Botanical species.	Botanical varieties.	Horticultural races.	Horticultural varieties.
I. *Trifoliata*			Trifoliatas.
II. *Aurantium*	*amara*		Sour. Bitter sweet. Seville.
	bergamia		Bergamot orange.
	sinensis	The common oranges	Bahia. Valencia. Homosassa. Pineapple. (Also other varieties
III. *Nobilis*		The mandarin group	Satsuma. China (mandarin). Dancy (tangerine). Oneco. King.
IV. *Decumana*		Pomelo (grapefruit)	Royal. Pernambuco. Triumph. (Also other varieties
		Shaddock	Paradise. Forbidden Fruit. (Also other varieties
V. *Japonica*		Kumquats	Nagami. Marumi (Also other varieties
VI. *Medica*	*genuina*	Citron	Corsican. Lyman. Orange. (Also other varieties
	lemon	Lemon	Lisbon. Villa Franca. Sicily. Eureka. (Also other varieties
	acida	Lime	Imperial. Mexican. Persian. (Also other varieties

SELECTING VARIETIES.

Experience has taught that no variety of citrus is preeminently useful for all portions of the world where this fruit is grown. As an illustration we have the Bahia, or Washington navel orange, which is preeminently adapted for California, but of little value in Florida or the West Indies, since it produces only a small crop except on rough-lemon stock, which stock is only adapted to a restricted area. Certain varieties of pomelo have exquisite flavor when fruited in Florida, but are not of the same excellence when grown in California. The pineapple orange and the Indian River orange are among the finest of fruits when grown in the sections where they originated, but when produced in Jamaica they can not be said to have superior qualities.

It becomes necessary, therefore, to test the particular variety in the section into which it is to be introduced. Some of the varieties are excellent in places far removed from one another, as is illustrated by the Satsuma, or onshu, an introduction from Japan, and the Bahia orange, which was brought from Brazil by the United States Department of Agriculture and is now so extensively grown in California. The last-named variety produces fruit of excellent quality when grown in Florida, but, as stated, is not prolific except on rough-lemon stock. Frequently the most important varieties of citrus for any given locality are those which have originated as seedlings in that section, and occasionally they may arise as bud varieties. An illustration of a variety arising as a bud variation is the Surprise navel, originating in Mr. E. S. Hubbard's grove at Federal Point, Fla., from buds received from California. Seedlings, as a rule, "sport" or are exceedingly variable; they, however, come true to seed within certain limitations. So far as known, a pomelo can not originate from an orange seed except where an orange flower is pollinated from a pomelo, and it is then not a true pomelo. Seedlings from the mandarin group reproduce a typical mandarin fruit. Seedlings from the sweet orange produce a typical sweet orange. Seedlings from pomelos produce pomelos of varying qualities.

The total number of varieties of citrus fruits that have been catalogued and described would run up into the thousands. Nearly every one has some peculiar merit for a particular locality. Out of the many thousands a few selected ones are of general value, and can be planted with safety over a considerable area. The following very brief list gives some of the varieties for the localities mentioned:

Florida.—The Florida State Horticultural Society has divided the State into four horticultural sections known as western north Florida, eastern north Florida, central Florida, and south Florida.

Eastern north Florida includes "that part of the State between the Aucilla River and a straight line drawn across the State from the mouth of the St. Johns River to Cedar Keys."

The following citrus fruits are considered especially adapted for this region: Of the sweet orange group, Parson Brown and Sweet Seville; of the tangerine group, the Satsuma; of the kumquat group, the Marumi and Nagami.

Central Florida includes "that part of the State between the line above referred to and the counties constituting south Florida."

Of the sweet orange group well adapted to this section may be mentioned Centennial, Tardiff, Homosassa, Jaffa, Majorca, and Parson Brown; of the mandarin group, Satsuma, China, Dancy, and King; of the pomelo group, De Soto, Duncan, Excelsior, Hall, Marsh, Pernambuco, Royal, and Standard.

Shaddocks and citrons are not grown as commercial fruits, and Nagami is the leading variety of kumquat for this section.

South Florida includes the following counties: Brevard, Dade, Monroe, De Soto, and Manitee.

The sweet oranges recommended for this section are the Bahia on rough-lemon stock, Tardiff, Homosassa, and Majorca; of the mandarin group, China, Dancy, and King; of the pomelo group, De Soto, Duncan, Excelsior, Hall, Marsh, Pernambuco, Royal, and Standard.

Shaddocks are not grown commercially, and are found only as ornamentals or novelties. In the kumquat group the leading variety is the Nagami. Citrons are grown only as occasional specimens.

Lemons are not grown as extensively in Florida as in California. There are, however, some good orchards of this fruit, the varieties principally produced in south Florida being Belair, Genoa, Imperial, Sicily, and Villa Franca.

On the keys and the adjacent coast considerable quantities of limes grow without cultivation and are apparently naturalized. The Department of Agriculture has distributed various importations of limes into south Florida, and nearly all of these varieties do very well. The peculiar demands of the market, however, are such as to make lime growing unprofitable. Nevertheless, very high prices are paid for the limes which are gathered from trees occurring spontaneously on the coast and keys. This lime is generally spoken of as the Key lime. It is a very small fruit and intensely acid, and usually contains many seeds. This same lime when taken to the mainland and put under cultivation produces a large fruit, with very thick, rough skin, approaching in size and appearance that of the usual lemon. Limes of this size do not meet with ready sale.

Louisiana and Mississippi.—The citrus-growing section of Louisiana and Mississippi occurs in the region closely bordering on the Gulf. In Mississippi it is near Biloxi, and in Louisiana it is south of New Orleans.

In these sections the common sweet orange grown is known as the Creole. This, strictly speaking, is not a variety, but an assemblage of seedling oranges that have been cultivated in this region for some time. Of the mandarin group Satsuma and China are the leading varieties. Of the pomelo group only a few are grown, these being the earliest varieties, such as Royal and Triumph.

Porto Rico and the West Indies generally.—Citrus growing throughout the West Indies is in a rather formative state. The efforts at systematic work in this line have not been carried forward with the same degree of vigor as in California and Florida. Nearly all the varieties recommended for south Florida may be planted with more or less confidence in this region. After years of experimenting in this region local varieties will doubtless develop which will prove better than some of the sorts now introduced on these islands.

PREPARATION OF THE LAND.

As a rule the field chosen to be planted out to an orange grove is land with a native growth upon it, which has to be removed. Usually the land is covered with forest trees. Various devices have been used for reducing the amount of labor necessary to get rid of this native growth, but up to the present time no substantial or decided progress has been made in the methods of clearing land. The most of the work is done by main strength and muscular labor. Where the native growth happens to be some form of hard wood, it is the usual practice to remove the trees and stumps. Some advantage is frequently obtained by the use of dynamite or other explosives in loosening the stumps. Where the native growth is pine woods or palm trees, the necessity for removing the stumps is not so great, though in the case of the former the stumps are usually taken out. In cabbage palmetto hammocks some of the trees are left and used as nurse plants for a few years. The ideal course is to remove all trees, shrubs, and other forms of vegetation from the land and to clear it of all rocks and any other débris that may be found. Then the land may be broken up and put into a first-class state of tilth, which will permit careful staking and planting.

SETTING OUT.

Usually the prospective orange grower buys trees from a nursery and sets them out as soon as the field has been cleared, wishing, of course, to get the trees on the land as soon as possible and to hasten the time when he may be selling fruit. Sometimes this is by no means the most profitable procedure. Land especially rich in organic matter and heavily matted with roots from the native growth would be decidedly better for having produced a crop or two of vegetables before the grove was planted. If for any reason it is not desirable to grow vegetables, a crop of weeds grown on it for a year would do much to sweeten the land preparatory to receiving the trees from the nursery. A crop of cowpeas or velvet beans would be preferable, however.

The number of trees to be set out to the acre depends on the variety selected and the character of the land. Large-growing citrus trees, such as pomelos and the Bahia and Tardiff sweet oranges, should not be set closer than 100 to the acre, and on first-class soil 75 are enough. Smaller-growing varieties, such as the mandarin group of oranges and the limes, should not be set closer than 200 trees to the acre. The character of the land will also need to be considered in setting out a grove. In a sandy loam, rich in organic matter, trees grow much more vigorously, and in consequence should be set farther apart. In the heavy clay soils trees grow less vigorously and may be set nearer together.

TIME AND MANNER OF SETTING OUT.

The time of setting out trees from the nursery will depend on the location and the conditions. In the West Indies and south Florida trees may be set out at any time of the year when the land is ready and there is sufficient moisture to favor their growth. In central Florida, the spring (February and March) is preferable. The same is true of north Florida, Louisiana, and Mississippi. In the extreme northern portions of the citrus-growing section it is usually better to wait until the danger of freezing weather is past. This will bring the date up to about the latter part of February. In setting out trees from the nursery, care should be taken to injure the roots as little as possible. Where trees can be taken up with a considerable ball of earth and transplanted in this way, they may be set out without any apparent check in growth. This, however, is not usually practicable in sandy soils.

When the trees are taken up the roots should be carefully protected by means of wet cloths or moist moss and the trees set in holes already prepared for them. If the ground is not already very moist the addition of one or two pails of water will usually puddle the roots and cause the trees to grow promptly. At the time of setting out, the tops should be cut back to correspond closely to the condition of the roots. The favorite size of tree to set out is one that has grown about 4 feet tall in the nursery and has several branches. Such trees are usually about an inch or an inch and a half in diameter at the crown.

CATCH CROPS.

As soon as the field has been set to a grove, cultivation may be begun. The kind and amount of cultivation will be determined by the character of the soil. Light, sandy soil should have shallow but careful cultivation. Heavy clay soils need thorough and deep working. Where there is an abundance of moisture supplied naturally to the soil, other crops may be grown to advantage between the orange trees. Where the soil is inclined to be dry and irrigation has to be practiced, this is of doubtful utility in the dry season. During the winter, vegetables may be planted and cultivated as in ordinary fields with decided advantage to the orange tree unless the land is too dry. Leguminous cover crops may be planted as soon as the spring and summer rains begin. When fall droughts occur the cover crops will have to be removed to conserve the moisture of the soil. Cultivation should then be resumed. If the soil is inclined to be sterile the cover crop should be used as a mulch for the trees. If the ground is sufficiently fertile to permit it, the cover crop can be utilized for hay.

PRUNING.

"To prune or not to prune; that is the question." At many of the meetings of the horticultural societies the question of pruning has been vigorously discussed. There are many good reasons for pruning trees; on the other hand, there are reasons why trees should not be pruned. The question, then, must be decided by each individual. One point, however, has been very well settled, and that is that low-headed trees are preferable. Twenty-five or thirty years ago it was a common practice to have citrus trees trimmed high enough to permit a man to drive a cultivator under the branches. The severe cold of several winters has caused this custom to be very largely abandoned. In the southern part of Florida, where there is no danger from frost, it has been found that shading the ground by the limbs has been very beneficial to the grove. Another important advantage in low-headed trees is that the fruit may be gathered much more cheaply than from tall trees.

Nearly all orange growers will agree that the pruning out of dead and worthless branches is of benefit to the tree. The extent to which sound wood is pruned out, however, varies with the notions of the individual grower. Some of the most extensive and best growers in Florida practice no pruning at all. Diseased branches should always be cut out, removed from the orchard at once, and burned. Sprouts that start from below the bud must be removed, and this should be done as soon as possible. Water sprouts need not and ordinarily should not be removed. There are conditions under which removal is entirely proper, but the very common practice of removing them simply as a pastime is a very harmful occupation. The fact that a water sprout appears shows that the tree is in a position to elaborate more reserve material than can be elaborated by its present leaf area. After a year or two years these water sprouts produce an abundant crop.

A citrus tree should be kept in a low, compact form, but violent pruning, such as is often practiced in deciduous fruit orchards, is not only unnecessary but often absolutely harmful. There are special cases, such as lemon orchards, and there are some regions in which trees must be mutilated to make them fruit; but that does not affect the general rule that citrus trees should be sparingly pruned or not at all.

FERTILIZERS.

Under the general heading of fertilizers, materials which may be employed to enrich the soil or cause it to produce a heavier crop may be considered. Ordinarily, the term "fertilizers" is restricted to such as are considered commercial articles, while the term "manure" is applied to organic offal and refuse accumulating on the farm. In some parts of the United States the term "guano" has been used to designate commercial fertilizers. Cover crops which are grown on the land for the purpose of enriching the soil are frequently called "green manures."

The kind of fertilizer required to produce a heavy crop of oranges varies greatly. In the West Indies, Mexico, Mississippi, Louisiana, and California the general constitution of the soil is so variable that no hard-and-fast rule can be given. In fact, in many cases it is doubtful whether the results desired attend the application of any or all the elements usually needed as plant food. While fertile soils produce trees of vigorous growth which often bear large crops of fruit, the possibilities are necessarily limited to what Nature will do; but in soils where one or more of the elements of plant food are present in deficient quantity, the modeling of the fruit and the production of excellent qualities are more completely under the control of the skilled horticulturist.

The conditions under which the report referred to in the quotation below was made by Aliño (Experiment Station Record, Vol. XIII, p. 455) are somewhat similar to those found throughout a large portion of Florida:

Analysis of orange trees.

	Total ash.	Nitrogen.	Phosphoric acid.	Potash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent*
Fresh fruit	3.21	0.38	0.40	0.3
Leaf	6.00	.70	.10	.3
Wood	7.00	.70	.50	.7

On the above basis it is calculated that a hectare [approximately 2½ acres] of oranges containing about 250 trees and yielding, when in full bearing, 30,000 kg. [66,000 pounds] of fruit, would remove from the soil 114 kg. [250 pounds] of nitrogen, 129 kg. [284 pounds] of phosphoric acid, and 114 kg. [250 pounds] of potash. If these elements are returned to the soil the equivalent of 760 kg. [1,672 pounds] of nitrate soda, 705 kg. [1,544 pounds] of superphosphate of lime, and 225 kg. [495 pounds] of sulphate of potash will be required. This formula is intended for soils composed mainly of siliceous sand, with some lime and clay, having a good depth and capable during the summer of receiving copious irrigation. This is considered by the author [Aliño] the ideal soil for oranges. On other soils this formula can not be strictly adhered to.

The evil effects attributed to an excess of nitrogen are that it produces an exuberant growth of wood and foliage, while the resulting fruit is very coarse and thick-skinned, with little sugar or aroma and of bad keeping quality. The time of ripening is also retarded. With an excess of phosphoric acid the fruits are small, numerous, well flavored, and aromatic, with thin skin and poor pulp. "When potash is superabundant the tree does not grow very large, but the fruit is juicy, sweet, and of pleasant flavor."

As to the most desirable forms of fertilizers, the author prefers sulphate of ammonia in light soils and in those charged with organic matter. Nitrate of soda is better applied to heavy soils. Superphosphate of lime is considered the best of the phosphate fertilizers. "Only in gypseous soils and those humid and rich in organic residues should the phosphate 'Thomas' be employed." The sulphate and chlorid of potash may be used indifferently, though the sulphate appears to give more delicacy and fragrance to the fruit. In rather limy soils the use of sulphate of iron is considered beneficial. In those with a little lime, and especially if inclined to be rough and clayey, the use of gypsum is advised.

In fertilizing young trees materials furnishing about one-half the nitrogen and phosphoric acid and one-fourth the potash required for an orchard in full bearing, as noted above, are required. For old trees the following is one formula recommended: Sulphate of ammonia, 300 kg. [660 pounds]; nitrate of soda, 400 kg. [880 pounds]; superphosphate of lime and manganese, 800 kg. [1,760 pounds]; sulphate of iron, 300 kg. [660 pounds]; chlorid of potassium, 25 kg. [55 pounds], per hectare. In the case of orange trees which produce an abundance of wood, leaf, and flowers, with but little fruit, the author believes the defect due either to a deficiency of nutrition or to a deficiency of the phosphates which promote the fecundation of the ovary of the flower, or to a superabundance of nitrogen, " which by excessively expanding the sexual organs of the flower produces its abortion." The following formula is suggested for such trees: Sulphate of ammonia, 75 kg. [165 pounds]; nitrate of soda, 75 kg. [165 pounds]; superphosphate of lime, 1,000 kg. [2,200 pounds]; kainit, 300 kg. [660 pounds]; sulphate of lime, 300 kg. [660 pounds], per hectare. With orange trees suffering from gumming, the use of organic fertilizers, and especially horse manure, should be avoided. The only manure required for trees in the seed bed is the free use of horse manure.

The effect of fertilizing orange trees in Florida with different ingredients has been very thoroughly discussed by Dr. H. J. Webber in the Yearbook of the Department of Agriculture for 1894, pages 193–202. The closing paragraphs of this article are as follows:

Summarizing, it may be said:

(1) By a proper combination of the various elements used in fertilization one can undoubtedly largely govern the quality and flavor of the fruit.

(2) To obtain a fruit with thin rind, use nitrogen from inorganic sources in moderate quantities, with considerable potash and lime.

(3) To sweeten the fruit, use sulphate of ammonia in considerable abundance, decreasing the amount of potash.

(4) To render the fruit more acid, increase the amount of potash and use nitrogen from organic sources.

(5) If it is desired to increase the size of the fruit, as is sometimes the case, apply a comparatively heavy dressing of nitrogen in some organic form and slightly decrease the other elements. In the case of the tangerine and mandarin, where a larger size is usually desired, a heavy dressing of nitrogen fertilizers would favor this end, and is not objectionable unless carried to excess.

(6) Fertilization has an important bearing on diseases.

(7) Die-back, a serious malady, is in all probability the result of overfeeding with nitrogenous manures from organic sources. These manures if used at all should be applied with great caution.

(8) Foot-rot, although not primarily due to improper methods of fertilization, is no doubt considerably influenced by this cause.

(9) Insect diseases are also apparently influenced by the use of fertilizers, organic manures rendering the trees more liable to injury from this source than chemical fertilizers.

INJURIOUS ACTION OF MUCK.

Dr. H. J. Webber writes as follows regarding the use of muck as a fertilizer:[a]

Muck is very commonly applied in considerable quantities either in a raw state or composted with sulphate of potash, etc. Many growers rather fanatically hold to what they term natural fertilization. By this is usually meant giving the tree nourishment in the form in which they suppose it to be derived in nature. It is contended by many that muck is principally decaying vegetable matter, and that as this is the form of nourishment which the trees obtain in nature it must be a good fertilizer to use in cultivation. But it must be borne in mind that orange trees, as we cultivate them, are decidedly not in a state of nature, except that by the cultivation of centuries we have made cultivation and manuring natural conditions which the plant demands. Trees in nature bear fruits for seeds to reproduce the species; on the contrary, we grow fruits for market and favor a seedless variety. We want a smooth, thin-skinned, tender, juicy fruit that will sink in water. Nature does not pay particular attention to these characters, so we watch for freaks and sports, abnormal plants, which have the characters we desire, and when found we render these characters permanent by budding. Our aim in cultivation is not to produce the fruit we find in the wild state, but to modify that fruit to suit our purpose. One of the most efficient methods of accomplishing this is to vary the fertilization.

While it can not be denied that muck has in some cases given excellent results, it must be conceded that its extensive use has usually been of doubtful benefit and often has done positive injury. Groves which have had liberal dressings of muck are frequently much diseased and produce light crops; the oranges are usually coarse, thick-skinned, and sour; the productiveness is often lessened by premature dropping of the fruit; the tendency seems to be to bring on die-back, a disease which is of frequent occurrence in groves heavily fertilized with muck. What has been said of muck applies to a greater or less extent to the various forms of organic nitrogen used. The tendency of all organic manures rich in nitrogen is to produce a large growth which is weak and sickly. Growth and not fruit is stimulated, and the fruit resulting is usually of poor quality, inclined to be large and rough, with a thick rind and abundant rag.

STABLE MANURE OF DOUBTFUL UTILITY.

Regarding stable manure, Doctor Webber says:[b]

Barn manure is largely used by many growers, who still hold to the tradition that chemical manures are injurious to the plants. The benefits of barn manure in an orange grove are in serious question. The fruits produced by nitrogen from this source are, as above stated, usually large, coarse, thick-skinned, with abundant rag, and of inferior flavor. If barn manure is used—and most growers have a limited quantity and desire to use what they have—it should be spread over the grove lightly, so that each tree receives only a small amount. Where such manure is depended upon as the main element of fertilization, liberal dressings of potash should be occasionally applied. This will tend to correct the evils of an overbalanced nitrogenous fertilizer. What has been said as to the effect of muck and barn manure on the quality of the fruit applies equally to the effects produced by cotton-seed meal, blood and bone, tankage, etc. In general, organic fertilizers do not stimulate fruiting to the same extent as the mineral fertilizers. It is probably better economy to apply such fertilizers to annual crops, cereals, garden truck, etc.

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[a] Yearbook of the United States Department of Agriculture for 1894, p. 195.

[b] Yearbook of the United States Department of Agriculture for 1894, p. 196.

COMMERCIAL FERTILIZERS FOR FLORIDA.

The kind and quantity of fertilizer necessary to produce a maximum crop of fine fruit depend entirely upon the soil upon which the tree is growing. Many soils in the citrus regions contain an excess of all the elements necessary for the production of citrus fruits. When fertilizers are applied under such conditions no beneficial effect can be noticed from their use. An orange tree planted upon soil that contains large quantities of the necessary elements usually produces large fruit, but often of an indifferent character. Soils that are deficient in nitrogen, potash, and phosphoric acid can usually have these supplied from such sources and in such quantity as will produce fruit of the desired texture and consistency. It therefore happens that the finest and most delicious fruit is grown on rather sterile soil.

The entire piney woods of Florida may be said to be deficient in each of the three important elements of plant food—nitrogen, potash, and phosphoric acid. Soils are also found in which there is a deficiency of lime, so that frequently an addition of this element will prove of value. The hammock soils are usually sufficiently fertile to produce at least one crop, or even a few crops of fruit, without the addition of fertilizer. These, however, in time become depleted, and the elements of plant food then need to be supplied by substances from a commercial source.

In growing citrus fruits on soils that are deficient in all of the three important elements of plant food, a fertilizer of the following composition is desirable:

	Per cent.
Ammonia	4
Potash	10
Phosphoric acid (available)	6

For growing nursery stock or for trees not of a bearing age the amount of potash in the formula may be reduced 6 per cent, leaving the two other ingredients in about the above proportions.

The quantity of this fertilizer to be applied per acre will depend upon various conditions. About 15 or 20 pounds may be applied to each bearing tree per year, the quantity being decreased or increased from year to year, as results indicate. Calculating this on the basis of 100 trees per acre, 1,500 pounds per acre per year would be used for young bearing trees. Double this amount is very frequently applied, and sometimes three times as much is used.

The following table gives approximately the amount of material needed per acre, in the case of bearing trees, to supply a quantity of fertilizer equal in fertilizing constituents to 1,500 pounds of the foregoing formula:

		Pounds.
(1)	Sulphate of ammonia	250
(2)	Sulphate of potash, high-grade	300
	Or sulphate of potash magnesia (low-grade sulphate of potash)	550
(3)	Dissolved boneblack	550
	Or acid phosphate, 14 per cent available phosphoric acid	850

In the case of nursery stock and growing trees 2 per cent of the ammonia may be derived from an organic source. This would require approximately the following ingredients:

		Pounds.
(1)	Sulphate of ammonia	125
(2)	Dried blood	100
(3)	Sulphate of potash, high-grade	200
	Or sulphate of potash magnesia (low-grade sulphate of potash)	350
(4)	Dissolved boneblack	550
	Or acid phosphate, 14 per cent available phosphoric acid	850

If there is any tendency toward die-back the dried blood should be omitted, and the amount of sulphate of ammonia increased to 250 pounds. If a quick-acting fertilizer is wanted nitrate of soda (100 pounds) in place of dried blood may be employed.

Citrus growers wishing to compound their own fertilizers should give due regard to the substances from which the different qualities are derived.

Organic ammonia, as found in cotton-seed meal, dried blood, guano, and the various stable manures, is apt to produce a soft, rapid growth, and in certain sections, especially in Florida, is almost certain by continued use to produce die-back.

Nitrate of soda is soon taken up by the trees, but is easily washed out of the soil. Where it is used as the only source of nitrogen it has to be repeated from four to eight times each year, varying with the amount of rainfall and the character of soil.

Sulphate of ammonia is much slower in becoming available to the trees, and seems to be retained in the soil much more tenaciously than nitrate of soda, so that it need not be applied oftener than two to four times a year.

In the use of potash there is very little choice between the low-grade sulphate, which is also called the double salts of potash and magnesia, and the high-grade sulphate of potash.

In selecting phosphates, preference is given to dissolved bone or dissolved boneblack over dissolved rock phosphate, although some experienced orange growers consider the phosphoric acid derived from dissolved rock as good as that obtained from dissolved bone. Thomas slag has not been employed to any great extent in America.

PICKING.

In citrus growing, as in the growing of other commercial products, the agriculturist frequently does everything perfectly up to the time of harvesting his crop. He then gets in a hurry, and as a result of overhaste his product goes into the market in bad condition. This is especially to be regretted since so frequently his fruit is faultless when the time for picking arrives.

In picking citrus fruits the greatest care should be exercised not to include any imperfect specimens. The fruits should be separated from the tree by means of a clipper, cutting the stem off close to the fruit, leaving it smooth, so that when another fruit comes in contact with the cut stem it will not be injured thereby. The picked fruit should be placed in some sort of basket. Frequently the fruit is picked in sacks. While thousands of crates are picked in this way and the fruit is marketed in fairly good condition, first-class oranges in the prime of condition are apt to be either scratched or slightly bruised. Thoroughly ripe fruit is so filled with juice that it will spurt out if a thorn or the point of a knife blade be stuck through the skin. It must be taken to the packing house with the greatest care and permitted to cure before it is fit to pack. When the picker has secured as much fruit as can be conveniently put in a basket, it is turned into a field crate. These crates are usually of slightly larger size than the shipping crate, and so constructed as to make it possible to nest them for transportation to the packing house. After the fruit has been picked for some time and the skin has toughened and the fruit has been permitted to shrink to some extent, it may be handled with much less danger of being injured. This usually requires from three days to two weeks. At the end of this time the fruit is graded according to its appearance. This grading has to be done by hand, and requires the judgment of a man skilled in citrus sorting. Various names are given to the grades of oranges, such as brights, fancies, seconds, golden russets, russets, dark russets, and so on. Usually there are about three grades in a grove, the brights, golden russets, and russets. The brights are divided into fancies and seconds.

Lemons are picked while the color is green, the time of picking being governed by the size attained by the fruit. After picking it requires from one to several weeks to cure them properly for market. This is usually done in specially constructed houses, in tents, or in banks.

WASHING.

Citrus fruit grown on a tree free from disease and insect attack is usually in the most perfect condition possible. Its appearance can not be improved by washing or other mechanical process. But a very large proportion is not grown under such conditions. Russet fruit is not improved in appearance by washing or scouring, but fruit affected by sooty mold should be put through a washer. Sooty mold is a black fungus (*Meliola*, various species) that grows in honey dew, usually excreted by some insect. The insect that most frequently produces the honey dew in Florida orchards is the white fly (*Aleyrodes citri*). Sooty mold very frequently follows an attack of the soft scale (*Lecanium* sp.), but this insect is usually very limited in distribution as compared with the white fly. The coloration of sooty mold being due to a fungous growth on the surface of the fruit, it becomes necessary to use some mechanical means for removing it.

Various machines have been invented for accomplishing this purpose. One in very general use has a series of brushes, slightly larger than scrubbing brushes, arranged on a chain belt. The fruit is received in single file down a chute, at the bottom of which is water in which the fruit is washed. The water and the brushes cause a very decided improvement in the color of the fruit. Another form of cleaner is constructed from a cylinder about 2 feet in diameter and about 4 feet long (see fig. 1). An axle in the form of a gas pipe is run through the axis of the cylinder, a crank is attached to this, and the cylinder is then mounted on a frame so that it can be revolved by hand. The inside of the cylinder is carefully padded with canvas. Fruit is placed within the cylinder until it is about three-fourths full; the remaining space is then filled with wet sawdust. By revolving the cylinder the wet sawdust wears off the sooty mold very quickly. When the fruit has been cleaned it is turned out and dried and is ready to be packed. The sawdust used for this work must be as soft as possible and must be sifted to free it from any large particles that might scratch the rind of the fruit.

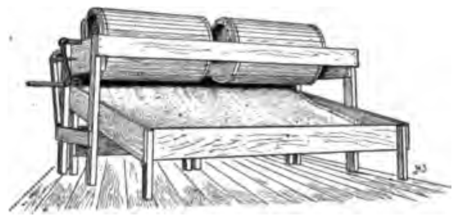


FIG. 1.—Homemade citrus-fruit cleaner used at Manavista, Fla.

SORTING.

After the fruit has been graded, it is run through a machine which separates it according to size. Various apparatuses are constructed for this work. One of the simplest is that made in the shape of a hopper with a chute running from it. This chute gradually increases in size, so that the fruits as they roll down drop into secondary chutes, which carry them into the field boxes from which they are taken to be wrapped. Lemons are usually picked when they have reached the desired size, which renders sorting for size unnecessary.

Another machine (fig. 2) makes a very satisfactory apparatus for sorting both oranges and pomelos. It is run by a treadle. The fruit is poured into the broad chute shown in the background and is allowed to run into two grooves. On the sides of these grooves, or runways, are long, thin cylinders provided with spirals. The runways as they pass away from the hopper widen, which permits the fruit to fall through when the proper width is reached. The cylinders provided with spirals revolve so as to carry the fruit forward. On each side and in front are compartments for receiving fruit of each size. Immediately in the foreground is seen a bench for holding a crate into which the fruit is packed by hand.

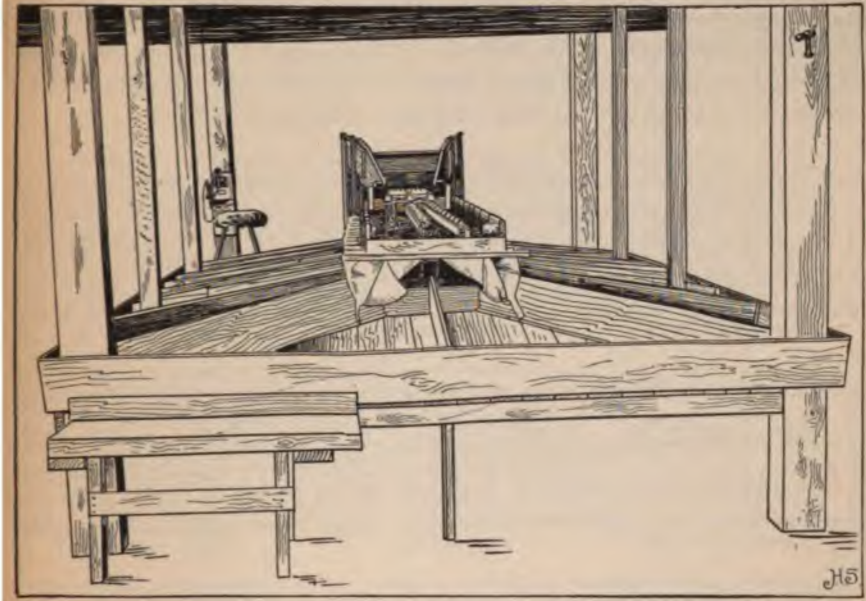


FIG. 2.—Machine for sorting citrus fruits.

WRAPPING.

The usual way of wrapping is by hand. This has been superseded in the larger packing houses by machines. The taste and care displayed in preparing the wrapping paper have frequently yielded good returns. In the large establishments wrapping paper having a suitable advertisement upon it, and often with a monogram or some other pleasing design, is used.

PACKING.

The packing may be done either by hand or by machinery. The greater quantity is packed by hand. The number of fruits and their arrangement in the box have been carefully worked out so that each fruit is placed in mathematical order. The orange and grapefruit crates commonly used contain a space of almost exactly 2 cubic feet. The outside measurements approximate $12\frac{1}{4}$ by $12\frac{1}{4}$ by 27 inches. As these crates are manufactured and sold to the grower all ready to nail up, he need give this matter no special attention. In packing, the boxes are usually filled so that the last tier of fruit projects about one-half inch above the top of the box. After the box has been carefully packed, it is placed under a lever or screw press and the lid gently forced into position. This is then nailed down and strapped, and is ready to be stenciled for the market. The accompanying diagrams

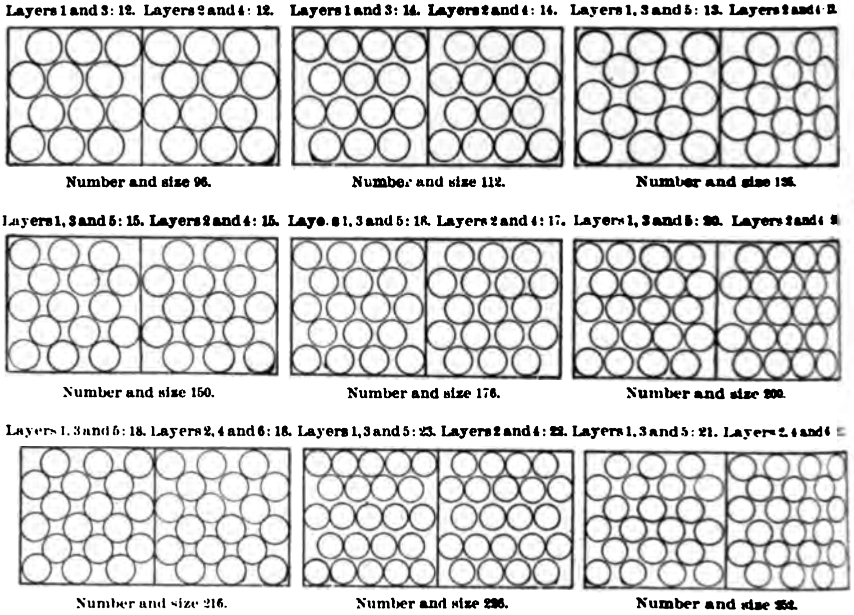
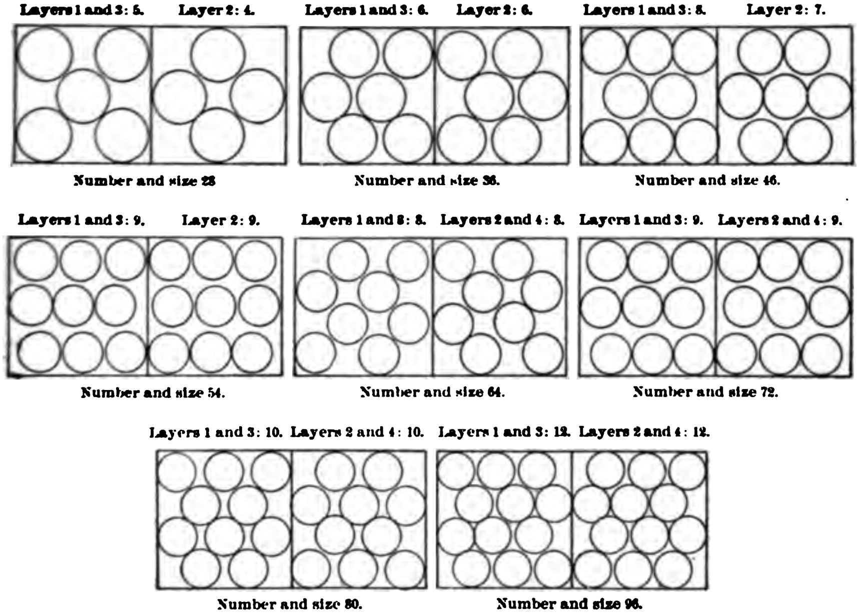

Layers 1 and 3: 12. Layers 2 and 4: 12.
Number and size 96.
Layers 1 and 3: 14. Layers 2 and 4: 14.
Number and size 112.
Layers 1, 3 and 5: 13. Layers 2 and 4: 12
Number and size 126.
Layers 1, 3 and 5: 15. Layers 2 and 4: 15.
Number and size 150.
Layers 1, 3 and 5: 18. Layers 2 and 4: 17.
Number and size 176.
Layers 1, 3 and 5: 20. Layers 2 and 4
Number and size 200.
Layers 1, 3 and 5: 18. Layers 2, 4 and 6: 18.
Number and size 216.
Layers 1, 3 and 5: 23. Layers 2 and 4: 22.
Number and size 226.
Layers 1, 3 and 5: 21. Layers 2, 4 and 6
Number and size 252.

FIG. 3.—Diagrams showing the arrangement of oranges of different sizes in crates: No. 96.—Diameter $3\frac{3}{4}$ inches; layers, 4. No. 112.—Diameter, $3\frac{1}{2}$ inches; layers, 4. No. 126.—Diameter, $3\frac{1}{4}$ inches; layers 5. No. 150.—Diameter, $3\frac{1}{16}$ inches; layers, 5. No. 176.—Diameter, $2\frac{15}{16}$ inches; layers, 5. No. 200.—Diameter, $2\frac{13}{16}$ inches; layers, 5. No. 216.—Diameter, $2\frac{11}{16}$ inches; layers, 6. No. 226.—Diameter, $2\frac{9}{16}$ inches; layers, 5. No. 252.—Diameter, $2\frac{7}{16}$ inches; layers, 6.

from Prof. H. H. Hume's Bulletin No. 63 of the Florida Agricultural Experiment Station, illustrate the arrangement of the fruit in the crates (figs. 3 and 4).

SHIPPING.

The moment the fruit is delivered to the transportation companies it passes out of the hands of the grower and beyond the possibility of his controlling the way in which it is handled. Not infrequently fruit put up in the very best condition and with the greatest care is slammed from the railway station into the car, and at its destination is again thrown from the car into a transfer wagon. Anyone wishing to be convinced on this point has only to follow his shipment past the transfer station and to its destination on the market. The most careful packing and best of packages are none too good. To a certain extent the shipper of fruit is powerless in this matter, and very frequently the transportation company's officials are ignorant of the rough handling. The only way to correct these abuses is by vigorous protest and definite action. All transportation companies are sufficiently interested in the matter to see in a general way that the fruit is handled with a certain degree of care, but as long as no strong protest is made they take it for granted that everything is satisfactory. No matter how carefully and exactly the fruit is packed, if the packages are abused in transit the results must be disappointing.



Layers 1 and 3: 5. Layer 2: 4.
Number and size 28.

Layers 1 and 3: 6. Layer 2: 6.
Number and size 36.

Layers 1 and 3: 8. Layer 2: 7.
Number and size 46.

Layers 1 and 3: 9. Layer 2: 9.
Number and size 54.

Layers 1 and 3: 8. Layers 2 and 4: 8.
Number and size 64.

Layers 1 and 3: 9. Layers 2 and 4: 9.
Number and size 72.

Layers 1 and 3: 10. Layers 2 and 4: 10.
Number and size 80.

Layers 1 and 3: 12. Layers 2 and 4: 12.
Number and size 96.

FIG. 4.—Diagrams showing the arrangement of pomelos (grapefruit) of different sizes in crates: No. 28.—Diameter, 5¼ inches, layers, 3. No. 36.—Diameter, 5 inches; layers, 3. No. 46.—Diameter, 4¾ inches; layers, 3. No. 54.—Diameter, 4½ inches; layers, 3. No. 64.—Diameter, 4¼ inches; layers, 4. No. 72.—Diameter, 4⅛ inches; layers, 4. No. 80.—Diameter, 4 inches; layers, 4. No. 96.—Diameter, 3¾ inches; layers, 4.

STORING.

A great many attempts have been made to store citrus fruits. With the exception of the lemon, storage is not thoroughly successful unless the fruit is put in cold storage. Various methods have been suggested, such as packing the fruit in Florida moss, packing it in dry road sand, storing it in caves, etc. The results of experiments with all of these, however, have been disappointing.

In general it may be said that citrus fruits may be stored in a cool dry place for two or three months without danger of serious loss. The temperature should not fall to the freezing point, and should not go much above 40° F. The air should also be dry enough to prevent moisture from forming on the fruit or packages during fluctuations in temperature.

In cold storage very fair success has been obtained in keeping the fruit, and when full information shall be at hand it will doubtless be possible to keep citrus fruits, at least in limited quantities, until the new crop comes in.

MARKETING.

The market selected for selling the fruit will vary with individual growers, the price being fixed by that obtained in the large markets, such as Chicago and New York. The price at the groves will be largely determined by the quantity of fruit supplied.

Where the fruit is sold on the trees, a definite written contract should be made, so that there is a full understanding as to the price to be paid for it, a date agreed upon at which all the fruit must be removed from the grove, and provision made for responsibility for injury to trees. The owner of the grove must expect to suffer more or less in the way of broken trees and limbs if the fruit is sold on the tree. Any unusual damage done to the trees, either by draft animals or by careless workers, should, of course, be borne by the person who buys the fruit and must be provided for in the contract.

A more satisfactory way of selling the fruit is at a definite price per box of a certain grade and size, delivered at the shipping station in first-class condition.

Usually the owners of small groves can not dispose of their fruit in the grove, but very frequently are able to sell it for a definite price at the shipping station. When the fruit is sold in this way, it is but fair and prudent to have a written contract giving full particulars as to prices, grades, sizes, and conditions. While much fruit is sold in this way, the great bulk of the fruit is shipped to the large markets to be sold. In such a case the grower should know to whom the fruit is consigned, having learned beforehand whether the sellers are responsible or not. While the determination of the financial responsibility of commission merchants or fruit handlers may seem difficult to the average grower, it is really a very simple matter to learn whether a business firm has any good reference or not. If the persons mentioned as references are addressed and no word is heard from them, it will be the safest course to assume that the reply would have been unfavorable.

PROTECTING TREES AGAINST COLD.

The disastrous freezes of 1894, 1895, and 1899 in Florida and the several minor cold spells that have destroyed a portion of the groves in California have caused the orange grower to cast about for some means of protection against a sudden cold wave. Two general methods have been practiced: The first is that of warming the air without providing shelter, and the second is that of providing a shed or shelter for the trees.

The methods of raising the temperature by means of fires, as described in the following paragraphs, can not be relied upon if the cold weather is accompanied by high winds or rainfall. In a portion of Florida during the heavy freeze of 1899 not only a heavy rainfall but heavy winds accompanied the cold. All attempts at building fires were useless, and even if they could have been built the wind would soon have carried the warm air out of the fields.

When a very moderate breeze is blowing and the temperature falls only 4 or 5 degrees below the danger point, fires on the windward side of a grove only need be lighted. The wind carrying the warm air across the other portion of the grove protects it from danger, and the constantly burning fuel keeps the air warm on the windward side.

PROTECTION BY HEAT.

Several forms of "heat protection" are advocated. The one in general use and of considerable value is that of heating the atmosphere by means of wood secured from the neighborhood.

Wood fires.—In a wooded country the form of protection against cold afforded by fires is cheap and at the same time very effective when a still cold occurs. The wood is piled in the centers of the squares, varying in quantity from three or four to a half-dozen or a dozen sticks of cord wood. When a freeze is predicted, the watchers notice the thermometer and by the time the cold approaches within 2 or 3 degrees of the danger point, which is 28° F. for fruit and 24° F. for foliage, fires are started in alternate squares. These will usually heat the grove some 4 or 5 degrees. If the cold continues to increase, all the piles of wood are started. It is of course necessary to have on hand a reserve stock of fuel in such an emergency. Shortly after the sun rises the next morning the temperature will usually have risen again, so there will no longer be any danger to the fruit or trees. If there is no favorable change in the weather, the cold on the second night is quite likely to be more severe than on the first. Firing then must be begun much earlier, and consequently a greater quantity of wood will be needed.

Coal baskets.—In California, Louisiana, and portions of Florida, baskets are made from heavy wire or heavy straps of iron which hold from eight to twelve quarts of coal. These are set about in the grove, much in the same way as wood is distributed. Late in the autumn, coal is placed in these baskets and covered with some cheap material, such as scraps of boards or palmetto fans, and is left in this condition. When the coal is to be used, a small amount of kerosene oil is poured into each basket, and the coal is lighted from the bottom. At times, wood from the southern pine, which is heavily impregnated with resin, is used as a starter in the bottom of these baskets. A supply of coal must be distributed in various parts of the orchard, and after the fires have been burning for some time the coal in the baskets is replenished.

PROTECTION BY IRRIGATION.

In the citrus-growing sections the water that is freshly pumped from the soil is quite warm, ranging from 50° to 74° or 75° F. When this water is carried through a grove in irrigating ditches, it gives off a considerable amount of heat, and has been used effectively in some instances where the temperature has fallen but slightly below the danger point.

Arrangements have also been made to throw this water into the air from spray nozzles. This is somewhat more effective than when the same quantity of water is carried through irrigating ditches, but can not be relied upon as being sufficient during extremely cold spells. During one of the recent cold waves the orchard of Mr. Theodore Mead, at Oviedo, Fla., was protected in this way one morning when the trees were covered with so heavy a coating of ice that some of the branches broke. The following summer the trees bore a crop of fruit.

The waters from artesian wells have also been used for the purpose of warming citrus groves, this water being quite warm, running into the sixties usually and as high as 74° F. in some wells. While this use of water does some good and protects that portion of the grove in the immediate vicinity of the large flow, the amount of heat given off is small and the volume of water supplied is not large enough to protect the grove to any considerable extent.

PROTECTION BY SHEDS.

The most successful method of protecting citrus trees from extremely cold weather is that of building a shed over the grove. At first thought this would seem to be entirely too expensive and not at all feasible, but the sheds have now been used long enough to demonstrate fully that they are not only possible but practicable. There are several modifications of the shed.

Sheds giving half shade.—Some of the orange sheds are modeled after the pineapple sheds of the east coast of Florida. These are light structures made of various kinds of lumber, usually such as can be obtained within a reasonable distance of the place where the shed is to be constructed. The essential parts of these sheds are the tops and sides. The sides, as a rule, are made a solid wall, while the tops, as the term indicates, give only half shade. Various materials are used for these tops, among the most common being plastering lath 4 feet long and 1½ inches broad (see fig. 5), and cypress slats 2 or 3 inches broad, one-half inch thick, and of lengths varying from 10 to 18 feet. Sometimes material 1 inch thick and 3½ inches broad and of varying lengths is used. The posts are usually 12 or 14 feet long, set into the ground 2 or 3 feet, at such distances apart as the length of the lumber would dictate. A very common spacing is to make the rows of posts 16 feet apart and 8 feet apart in the row. Planks 2 by 6 inches and 16 feet long are nailed to the tops of these posts, and where the cover lumber is 1 by 3 inches and 16 feet long these pieces are nailed across the 2 by 6 inch planks. Where plastering laths are used, planks either 2 by 2 inches and 16 feet long, or 1 by 3 inches and 16 feet long, are nailed on top of the 2 by 6 inch plank, and the laths are nailed to these latter stringers. Sometimes the plastering laths are woven by fencing machines between wires, and these are spread over the stringers. In all these cases the spacing between the roof material is just equal in size to the width of the material used, thus permitting one-half of the sunshine to pass through the slats; hence the term "half shade."

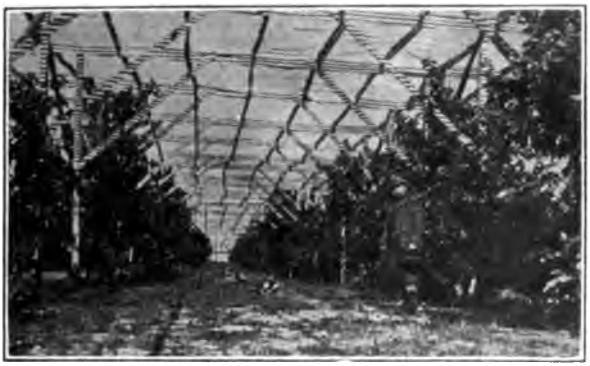


FIG. 5.—A shed giving half shade. (Grove of H. L. Ives, Cocoa, Fla.)

Sheds giving one-third shade.—Another form of shed in use is made more rigidly than the one previously described, and has a solid roof built over the entire area. This roof is made in sections about 6 feet wide running across the field, two-thirds of these sections being movable. Two movable sections are taken up in the spring after danger of freezing is past, and are piled upon a third section, which is permanently placed. Under this arrangement the trees receive approximately two-thirds of the sunshine.

Sheds with removable tops.—Another form of shed is one in which the entire top is movable, and at the close of the winter all these tops are taken up and stored in a dry place.

Results obtained by using sheds.—All of these forms of sheds are more or less successful in accomplishing the end designed. The trees grow luxuriantly under these conditions and will endure freezes of a more severe nature than those experienced in the localities where the sheds are built. In the places where sheds are popular, the owners usually go to the additional expense of providing some form of heating apparatus. The tops being half closed or entirely closed, according to the type of shed, the heat is confined under this, and only a small quantity of fuel is consumed in keeping the temperature above the danger point.

Under the sheds which produce half shade, the trees usually grow very slender and produce only a comparatively small amount of foliage (see fig. 5), and on the whole produce a smaller crop of fruit. The fruit which is produced is of a superior quality, however, so that the reduction in quantity is compensated for by the improvement in quality.

PROTECTION BY TENTS.

In addition to the protection afforded by heating, irrigating, and the use of sheds, tents have been devised for protecting the trees against freezes. These are intended not as permanent structures but as a protection until the trees in the grove have become of such size as to afford a considerable protection to one another. Two forms of tent that have been used extensively possess considerable merit. One is a square or box tent, so called because of the shape of its base, and of sufficient height to take in the desired tree. In addition to this, kerosene lamps are provided, which are lighted on critically cold nights. On warm days one side of the tent is opened, so as not to overheat the atmosphere inside the tent, but to keep the tree dormant until spring arrives.

A circular form of tent is so arranged that by pulling a cord the tent closes automatically. When the weather becomes severely cold, lamps of suitable size are placed under these tents to keep the temperature from falling too low. As these tents are opened very easily, it requires but little work to open and close them; consequently they can be opened readily as soon as the danger of freezing is past. During summer they are taken down and stored in a dry place.

TOP-WORKING.

It sometimes happens that a grove is planted out to a variety that does not prove prolific, or one that may be unprofitable to market. In such a case it becomes necessary to abandon the grove or to top-work the trees. With the trees in a healthy and vigorous condition most or all of the top should be removed, only two or three vigorous limbs being left. Buds of the desired variety may be inserted into the limbs that remain. The mutilation of the tree caused by cutting away most of the top causes a heavy flow of sap into the smaller limbs which remain. In such cases the buds will "take" where they would fail if the top of the tree had not been vigorously cut back.

Another way of top-working is to cut away nearly all of the top and then wait for sprouts to start. After the sprouts have reached a size of about half an inch in diameter they may be budded, and the bud will take readily. When trees have been cut back severely, the bodies and the larger limbs should receive a heavy coat of whitewash. This protects the trees against sun-scald.

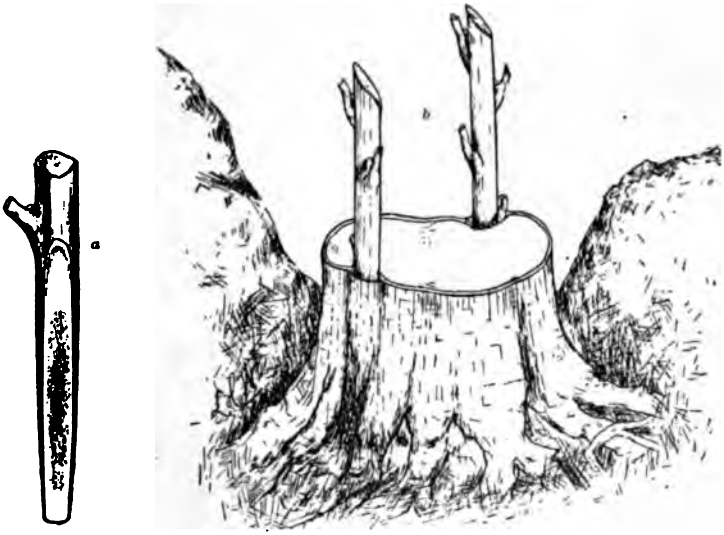


FIG. 6.—Method of crown-grafting an old orange stock: *a*, base of scion, showing slanting cut; *b*, method of inserting scion. (From Yearbook U. S. Dept. Agr., 1895.)

Before top-working, the orchardist should be well acquainted with his grove and soil. In a very large portion of Florida severe top-pruning results in die-back unless proper fertilization and soil treatment accompany the work.

In California it appears to be safe to remove the entire top and to work buds into the large limbs. For top-working, the shield bud (see figs. 12 and 13) and sprig graft (see fig. 8) may be used to best advantage. In the latter case the sprig is placed in a large limb or branch.

CROWN-WORKING.

At times it becomes desirable not to permit the body of the tree to remain. In such cases the trees may be cut off at the ground line. Some citrus trees, especially limes, resent treatment of this kind, and fail to grow after the top has been entirely cut off. The ordinary citrus stock, however, is almost certain to sprout again if treated in this way. Frequently large areas, 20 to 40 acres in extent, were sprouted in this way after the great freezes in Florida of 1894 and 1895 without the loss of a single healthy stump.

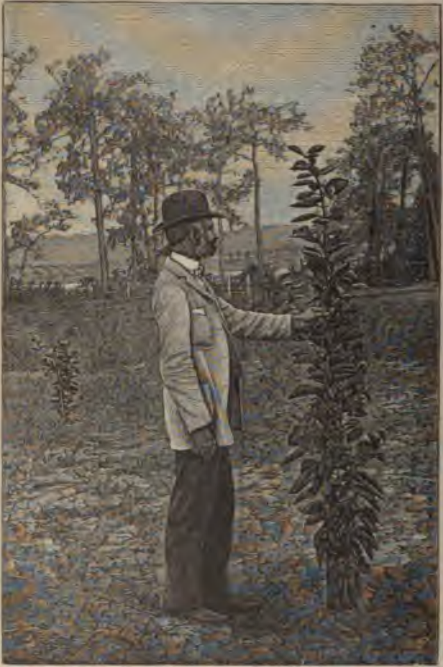


FIG. 7.—Ruby orange bud, put in May 21, on sprout from old sweet-orange trunk, as it appeared on October 25. (From Yearbook U. S. Dept. Agr., 1895.)

Trees that have been cut back in this way may be crown-worked or crown-grafted, as illustrated in figure 6, the sprig being inserted in the portion of the crown that will take it most easily. By slipping the scion into the portion of the crown where the bark may be raised without breaking, the work may be done without the use of wax or other binding material. After the scion has been inserted, moist earth should be raked over the crown and around the scion, covering them until they have "taken," and then exposing the tips. Where this work is done by experienced hands, only a very small percentage of the crowns fail in taking one or more sprigs. Those that fail to take may be worked again or left to produce sprouts and then budded into these sprouts. By using three or four such scions in a crown 4 or more inches in diameter and doing the work during February or the early part of March, the percentage of loss sustained will not be very great.

Another method of renewing such an orchard is to wait until the sprouts have started from the crown or the main roots. After these sprouts have reached a size of half an inch or so, buds are inserted as low down as practicable. In doing this, however, a considerable loss of time will be sustained in waiting first for the sprouts to start and en again in cutting them back to make the buds. The loss of time strikingly illustrated by the two accompanying figures made from otographs (figs. 7 and 8).

THE NURSERY.

The nursery is the starting point of the citrus grove. It is, there- re, one of the factors of greatest importance. No matter how well e climate may be suited to the growing of fruit or how well the ove may be cared for after it is planted out, if improper selections ve been made in the matter of stock or of buds, failure is just as rtain as if improper selection had been made of the locality in which grow the fruit.

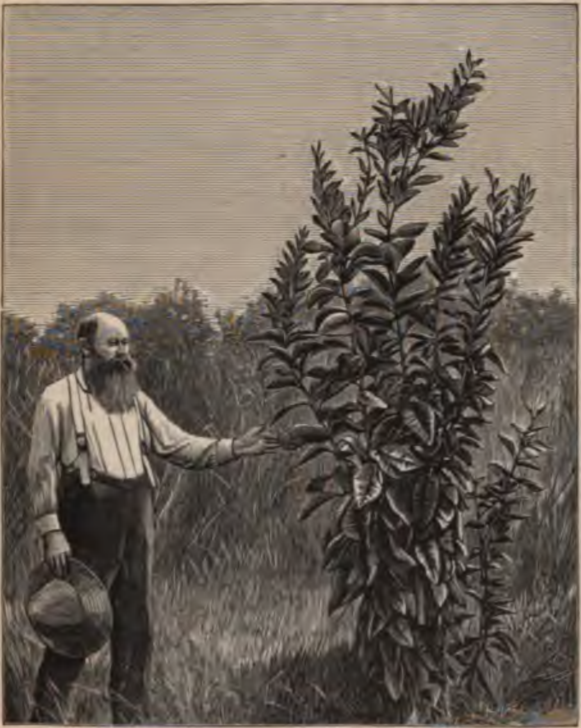


FIG. 8.—Ruby orange crown-graft, put in March 1, as it appeared on October 23. (From Yearbook U. S. Dept. Agr., 1895.)

SUITABLE STOCKS FOR DIFFERENT SECTIONS.

Each of the principal citrus-growing regions of the United States s a stock which is best adapted to its own peculiar conditions. ven in the larger citrus-growing regions the variations of soil are ch as to demand a different kind of stock or bud. This discussion has been partially covered in the section on varieties and in that on soil.

Louisiana and Mississippi.—In Louisiana and Mississippi the soil is a heavy clay, very fertile, and usually quite moist. Citrus trifoliata, or trifoliata, as it is commonly called, is preeminently the stock for use in this section. Here it not only is a vigorous grower but also imparts more or less of hardiness to the scion by becoming dormant in the autumn because of the fact that the trifoliata is a deciduous species (fig. 9).

Eastern north Florida.—In the eastern part of north Florida the trifoliata is also the best stock to use, for the reason given in the preceding paragraph. Much of this region is also a rather heavy, sandy soil inclined to become clayey. In the deep, sandy portion of this section some of the more rampant-growing stocks do equally as well as or possibly better than the trifoliata, but they do not produce quite so hardy a tree.

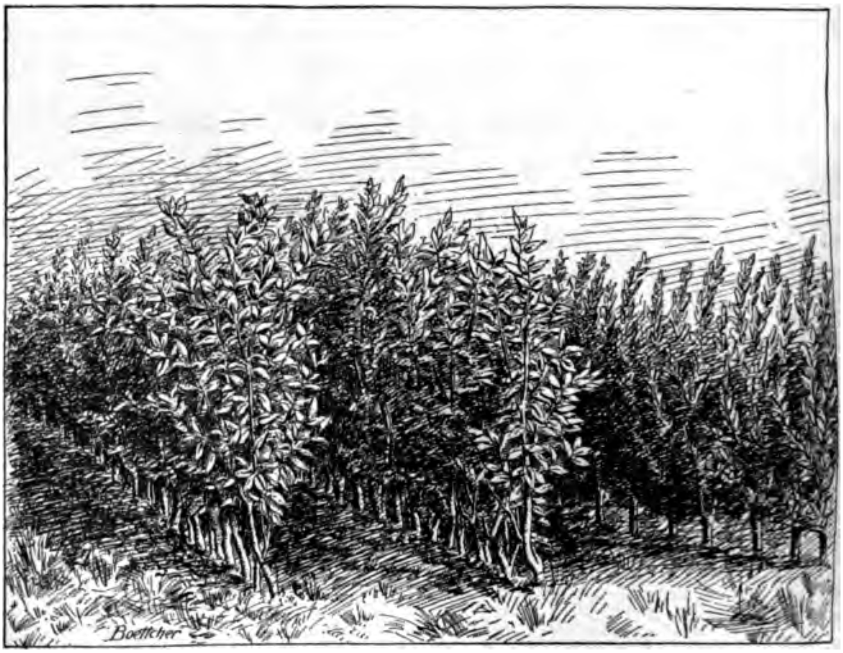


FIG. 9.—Citrus nursery at Naomi, La.: Trifoliata stock and mandarins to right; pomelos to left. Buds of one summer's growth.

Central Florida.—Throughout central Florida the soil is inclined to be sandy, but usually contains a considerable quantity of decaying vegetable matter. On this soil the pomelo stock does best, although it does not make quite so hardy a tree as the sour-orange stock.

h Florida.—The rough lemon is preeminently the stock adapted
n south Florida. It is a rampant grower, able to live on soils

that are almost sterile for the other stocks mentioned, but is inclined to produce a little more coarse fruit than the other stocks. In the heavy soils of this section, especially that which is free from limestone, the pomelo and sour orange may be used to good advantage. These trees are somewhat slower in growth, but produce a more smooth and velvety fruit and ripen more evenly. The lime seedlings have also been used for stocks in this section. This makes a tree rather sensitive to cold, and the earliest crops of the fruit are inclined to be somewhat rough and thick-skinned. The greatest drawback, however, from the nurseryman's point of view, is that the ordinary operation that would make 90 per cent of the buds live in rough-lemon stock would probably not give more than 50 per cent in the lime stock. It is therefore used very little.

SELECTING SEEDS.

In selecting seeds from which to grow nursery stock, one should choose well-matured specimens. It is a matter of indifference as to the perfection or imperfection of the fruit from which the seed be taken, but the seed should be plump and well filled and the fruits taken from the most vigorous trees. This is true for all the varieties that are to be used as stock. One is frequently able to secure a lot of pomelo drops or fruits that have been frosted, and from these secure large numbers of fine seeds.

There are various methods of obtaining seeds from the fruit. Where fruit has been damaged and thrown out to rot, the seed may be washed out from the rotting mass and the superfluous water dried off. The seed may be separated fairly easily by using an ordinary sieve with large openings by forcing the water on to the seed by the use of a force pump or from a tank. In the case of trifoliatas and rough lemons the fruit is of no other value than for the seed which it contains.

After gathering these fruits they are cut into sections with a dull knife and most of the seeds pressed out, and the cut sections are thrown into a barrel and covered with water. In a short time this mass will be sufficiently disintegrated to allow easy separation of the seed. Care must be taken, of course, not to let the material remain in the water sufficiently long to injure the seed. If the barrel is placed in a warm location, in three or four days the seeds will slip out easily, and they can then be separated from the pulp by washing.

The seeds that are squeezed out by hand need no special washing. They should be placed in the open in a shed to allow the superfluous moisture to dry off, and then are ready for preservation. Bonavia says that in India the seeds "are well dried in the sun for two or three days."

KEEPING SEEDS.

In the northern sections of the citrus-growing regions the seed must be kept for a considerable time before the ground is sufficiently warm to receive it. After the superfluous moisture has dried from the seeds, which will occur in the course of from one to three days, they may then be preserved in dry sand.

Where sand is not readily obtained, a fairly dry clay, such as will break up readily, and not sufficiently moist to pack, will be found useful. In this kind of material the seeds of trifoliatas have been shipped from Japan to Florida and have retained their germinating qualities perfectly.

PREPARATION OF THE SEED BED.

Where only a few thousand seeds are to be planted they may be germinated in boxes or trays. Taking a box which is about 8 or 10 inches deep, with its other dimensions of convenient size, 3 or 4 inches of soil is placed in the bottom. The seed may then be sown on this layer of soil, and an inch more of soil placed over the seed. Over this a layer of mulching, such as decayed leaves or sphagnum, or in fact anything that will keep the soil from drying out, may be placed, and in this the seed may be allowed to germinate and seedlings grown. The mulching should be removed as soon as the seedlings begin to come up.

The ordinary seed bed, or cold frame, as it is usually prepared by gardeners, is also an excellent place to germinate the seed and grow seedlings. In planting in beds of this kind the rows should be made 6 inches or a foot apart, and the seeds dropped 1 or 2 inches apart in the row. They may be left there until they have grown sufficiently large to be planted out in the nursery.

For growing seedlings on a large scale where hundreds of thousands are to be grown, it becomes necessary to make a careful selection of the spot where the seeds are to be planted. A place that is not in danger of being flooded or becoming too wet, and yet that will remain constantly moist, should be chosen. This land should be thoroughly broken up, plowed deep, especially if it is of a heavy or clayey nature, the rows laid off from 2 to 4 feet apart according to conditions, and the rows then opened up and a liberal application of fertilizer made. If the site happens to be a clay soil, it is well to break the rows at least 10 inches deep. Fertilizer is then scattered down the rows and worked in thoroughly by the usual farming implements. From two weeks to a month or so after the seed bed has been prepared in this way the seed may be sown. The furrows are thrown open 5 inches deep and the seed scattered down the rows, being sufficiently distributed to give each seed an inch or so of space. The rows may be made from 4 to 8 inches wide according to the needs and conditions. The seeds are then covered about an inch deep and the soil firmed about them. If drought follows the planting, it may become necessary to resort to watering to keep the seed from drying out.

TIME OF SOWING.

The best time to sow depends upon the location of the seed bed. In southern Florida and the West Indies the seed may be sown as early as December. In central and northern Florida, and in Louisiana, Mississippi, and California, it is better to wait until the soil is warmed up sufficiently to induce rapid germination and active growth. This time may be reached anywhere from the first of February until about the middle of March or later, varying in different seasons and in different localities.

CULTIVATION OF THE SEED BED.

The cultivation of the citrus seed bed is the same as that usually given to seeds of garden crops. At first light working, such as may be done with a garden rake, will be most useful. A skillful laborer may rake over a seed bed when the seedlings are coming through the ground with entire safety to the small plants. This raking may seem quite useless in many instances, but it is very important in that it conserves the soil moisture and breaks the crust if there is any tendency to form a hard surface. The middles may be cultivated with the usual shallow-going farm tools—a spring-tooth cultivator, a special harrow, or a hand plow. Cultivation should be repeated every week or ten days, and as the seedlings grow stronger the cultivation in the clay soils should be made deeper, until in midsummer or early autumn it has reached the maximum depth of farm cultivation. On the sandy lands cultivation should never be more than 3 or 4 inches deep, for on such lands the soil is already sufficiently loose and further stirring does not add to its productiveness.

TRANSPLANTING

Under favorable conditions the seedlings will have attained a height of from 6 to 12 inches and the diameter of a small pencil by autumn or by the next winter. The seedlings are then in good condition for transplanting. The time of transplanting is less definite than that of sowing the seed. In the West Indies and southern Florida transplanting may be done with good success any time after the seedlings are of sufficient size, depending on the favorable condition of the soil. In other citrus-growing regions transplanting is done in the spring or early summer, whenever favorable climatic conditions occur. Under some conditions seedlings are permitted to remain in the seed bed for nearly two years.

In preparing for transplanting on a large scale the nurseryman frequently uses a tree digger to run under the seedlings. This loosens up the ground on both sides, and at the same time cuts most of the taproots. The depth to which the tree digger should be run will depend on the amount of root growth the seedlings have made. In heavy soils transplanting is much facilitated by plowing a deep furrow on each side of the seedling row. A heavy spade may then be inserted under the row, and the seedlings lifted without much damage to the root system. Some means for keeping the roots moist after they have been removed from the ground should be provided.

PREPARATION FOR THE NURSERY.

The location of the nursery is of very considerable importance. The land selected can usually be slightly more moist than such as would ordinarily produce a good grove, but to be successful it should not be subject to flooding, nor should it be subject to drying out during severe droughts. The rows should be laid off from 4 to 6 feet apart, thoroughly broken out to a considerable depth, say, about 10 inches, and then prepared in the usual manner in which gardeners prepare their land for vegetables.

Thoroughly rotted stable manure will be found an excellent fertilizer in heavy clay soils. In the soils that are inclined to be sandy, commercial fertilizers will be found of greater advantage. The quantity of manure and fertilizer to be used will depend on the fertility of the land to be planted. Upon the ordinary sandy soils from 500 to 1,000 pounds of the formula previously recommended will be found entirely sufficient for the first application. On rich clay soils well-rotted stable manure at the rate of several loads to the acre will be found sufficient.

The rows should be prepared thoroughly and the land made ready about a month before the probable time for setting out the nursery stock. After the land has been prepared it will be no special harm if one has to wait longer than was expected before a favorable time for transplanting arrives.

When the time for transplanting arrives the seedlings may be taken out of the seed beds and transplanted into the nursery rows in various ways. The trees should be set about a foot apart in the row. Many nurserymen prefer to use a thin spade for transplanting, running this into the ground, bending it over, and setting the tree in. In this operation one man uses the spade while another man inserts the tree. When the spade is withdrawn, each man presses a foot near the tree and firms the soil tightly about it. In other cases the nurseryman prefers to simply run a furrow or double furrow down the row, set the tree firmly into position by hand, and then fill in the soil with a plow.

In setting the seedlings they should be placed so that the level of the soil is approximately at the same height on the seedling as when it grew in the seed bed. If the trees happen to be set an inch or so lower it will be of no serious disadvantage. In this work of transplanting, all small and inferior seedlings should be thrown out, as in all probability they will make only second or third rate nursery stock and will prove to be poor trees in the grove. What is wanted of nursery stock is a tree that has vigorous growth.

CULTIVATION OF THE NURSERY.

The cultivation of the nursery may begin immediately after the seedlings are set out. The cultivation at first need not be deep, merely running over with the finishing tools to conserve the moisture and keep the ground in good condition. Where the soil is sandy the cultivation at no time need be much more than this. In the heavy clay soils it is important to break up the soil as deeply and thoroughly as possible. The length of time elapsing between repetitions of cultivation will depend upon the conditions of the soil. In all of the work of cultivating citrus trees it should be remembered that the destruction of weeds is of secondary importance. Of course this should never be neglected, but the real value of cultivating lies in the fact that the soil is kept in a suitable condition of aeration. If a heavy, beating rain falls immediately after cultivating, much of the good effected by the work is lost, and consequently another cultivation should be made as soon as the soil conditions will permit.

SEEDLING GROVE.

In the early history of citrus growing main reliance was placed upon the propagation of trees from seed. Such trees, when grown to fruiting age, are usually spoken of as seedlings. The use of seedling groves has been almost entirely superseded by budded groves. At the present time very few seedling groves are being planted out. If one wishes to secure a seedling grove it is of the utmost importance to make a careful selection of the fruit from which the seeds are taken. Care should also be exercised not to use seeds from groves in which occurs a mixture of citrus varieties. The seedlings from such a grove will produce an exceedingly variable crop. Certain minor variations will occur in every orchard, however, no matter how carefully the trees may have been selected. In planting out a grove of this kind there is no certainty as to the quality of the fruit or the bearing propensities of the trees.

Another disadvantage of planting seedling groves is that such trees are later in coming into bearing than budded trees, and as a rule are of a more upright growth. The vigor of seedling trees is usually greater than that of the ordinary budded grove, but this is practically the only strong argument in favor of a seedling grove.

PROPAGATING BY CUTTINGS.

Lemons, limes, pomelos, and other citrus species propagate very readily from cuttings. The cuttings are taken from fairly matured wood and at such time of the year as will give considerable moisture to the soil and at the same time considerable warmth. While these cuttings have been employed for producing nursery stock on which to bud they are not nearly so satisfactory as seedlings, the growth being somewhat slower and not as straight and satisfactory for budding as when seedlings are used. Root cuttings from these various species may also be employed, but these have the same disadvantages that are encountered with the use of cuttings from the branch.

BUDDING.

There are various methods of propagating citrus trees—by budding, grafting, or inarching. While there are conditions under which grafting becomes necessary, and inarching must be practiced to obtain the desired end, budding is preeminently the best method of propagating citrus trees. The work is done so easily and may be accomplished with such certainty of good results that grafting and inarching as methods of increasing the stock of any particular variety must be considered obsolete.

The subject of budding was well covered by Dr. H. J. Webber in his paper entitled "Methods of Propagating the Orange and Other Citrus Fruits," which appeared in the Yearbook of the United States Department of Agriculture for 1896, and as no important improvements have been made since that date the following chapters, with the exceptions of those on time of budding and on cutting buds, are quoted without any modifications.

TIME OF BUDDING.

In regions where a more or less definite winter occurs, budding is practiced either late in the autumn, about November or December, and called dormant budding; or in the spring, after a vigorous growth has started. Good citrus stock may be budded at almost any time of the year, except during the winter in those sections where a decided lowering of the temperature occurs. In general it may be said that buds may be inserted at any time of the year when the bark of the stock separates easily from the wood. This always indicates a strong flow of sap.

CUTTING BUDS.

Some experienced nurserymen prefer to cut the bud sticks and keep these for a few days, or several weeks, before inserting the bud. It is thought by them that a larger percentage of the buds will take under these conditions.

SELECTING BUDS.

Bud wood should always be selected from fairly well-matured wood of the current year's growth. Round sticks (or as nearly round as possible) should be selected. The young growth of orange wood is at first angular, becoming rounder as the twig matures. The basal portions of the young branches, which are nearly or quite round (fig. 10, *a*), supply the best buds, with the exception of the first two or three, which are usually somewhat imperfect and should be discarded. Where it is difficult to secure well-rounded wood, angular wood which is not too soft (fig. 10, *b*) may be used. This, however, is not quite so satisfactory. Thorny bud wood should never be used when other wood can be obtained. Thorny trees are very undesirable, and a careful selection of thornless bud wood will soon result in thornless trees. The thorns have been bred out of many of the best citrus varieties, and if nurserymen would exercise proper care all the desirable varieties could soon be rendered thornless.

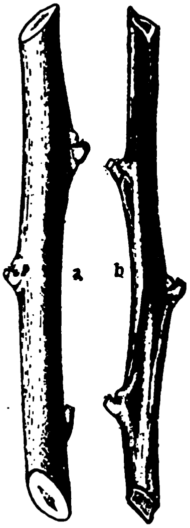


FIG. 10.—Sweet-orange twigs: *a*, round twig of select buds; *b*, angular twig of buds. (From Yearbook U. S. Dept. Agr., 1896.)

After cutting, the leaves should be pruned off and the twigs cut into sections of the desired length. To preserve the bud wood until needed the twigs should be tied up in convenient-sized bundles, carefully labeled, and packed in old sawdust in a box of suitable size. The box should then be closed and buried in sheltered ground several inches below the surface. In this way bud wood can be preserved in good condition for from two to three months. Dampened sphagnum, or peat moss, may be used instead of sawdust, but in this case considrable care must be exercised to get the moss properly dried. t must be moist, but not wet, for if too wet the bud wood may mold. The same caution applies also to sawdust. In this case the proper degree of moisture can be secured by taking the material from the interior of an old pile. Sawdust does not lose its moisture readily nd is the best material for packing. Some simply bury the bud wood in the soil nder shelter, digging down until the moist earth is reached.

MATERIALS FOR BUDDING.

Before beginning the operation of budding, material should be provided for wrapping the buds. For this purpose cotton cord, yarn, strips of waxed cloth, etc., are sed. The last named has practically superseded all others in Florida, being more onvenient and giving better results than any other wrapping material. The strips are made from strong muslin or calico. Before the cloth is torn into strips, it is folded into convenient size and dipped into a hot solution of wax made by melting together two parts of beeswax and one part of resin. Several formulas for making this wax are used, any one of which will probably answer. The method described is known from personal experience and observation to give good results. After saturating the cloth with the hot wax, all the superfluous wax should be removed before the cloth cools. To accomplish this quickly hang the piece of cloth, folded in convenient form before waxing, over a small, strong stick (fig. 11, *a*), which is held by an assistant. Then take two similar sticks of wood, and holding them parallel on either side of the cloth (fig. 11, *b*), press them firmly together and pull downward, squeezing out the superfluous hot wax. The cloth should then be spread out until cool, after which it is ready to be torn into strips of the desired size—that is, one-fourth to one-half inch wide and from ten to twelve inches long. The cloth may be torn into strips before it is taken into the field, or it may simply be torn into convenient-sized pieces and afterwards torn into strips in the field as desired for use. The latter is probably the most convenient way.

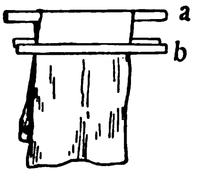


FIG. 11.—Method of removing wax from budding cloth. (From Yearbook U. S. Dept. Agr., 1896.)

Using waxed cloth for wrapping effectually excludes moisture, prevents the bud from drying out, and the work can be done more quickly than with string, as the strips cover more surface and do not require tying, the wax serving to hold the cloth firmly in place. It may therefore be recommended as far preferable to any other wrapping material.[a]

HOW TO BUD.

Budding is a simple process, consisting in inserting a bud of a desired variety under the bark of the stock in such a way that the freshly cut inner bark of the bud comes in close contact with the layer of growing wood (cambium) of the stock. The bark is closed over the inserted bud and the stock wrapped with waxed cloth, as described, so that the bud is firmly pressed against the growing wood. If the operation is properly performed, the tissue of the bud and stock soon fuse together and the bud may be forced to grow.

In all varieties and stocks of citrus fruits the process of budding is practically the same, the method commonly employed being that known as shield, or eye, budding (fig. 12). The bud is inserted in the young stock near the ground. Previous to the severe freezes of the winter of 1894–95 the general practice was to insert the buds 12 to 18 inches above the ground, but since then the tendency is to bud as near the surface of the soil as possible, so that the trees may be readily banked with the earth above the bud to protect against injury from

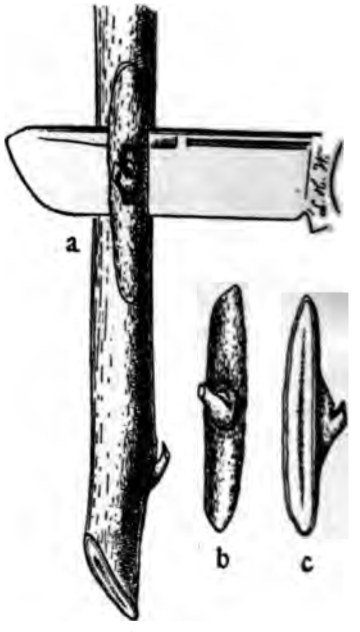


FIG. 12.—Shield, or eye, buds: *a*, method of cutting bud from round twig; *b*, bud cut ready to insert; *c*, face of bud showing the cut surface. (From Yearbook U. S. Dept. Agr., 1896.)

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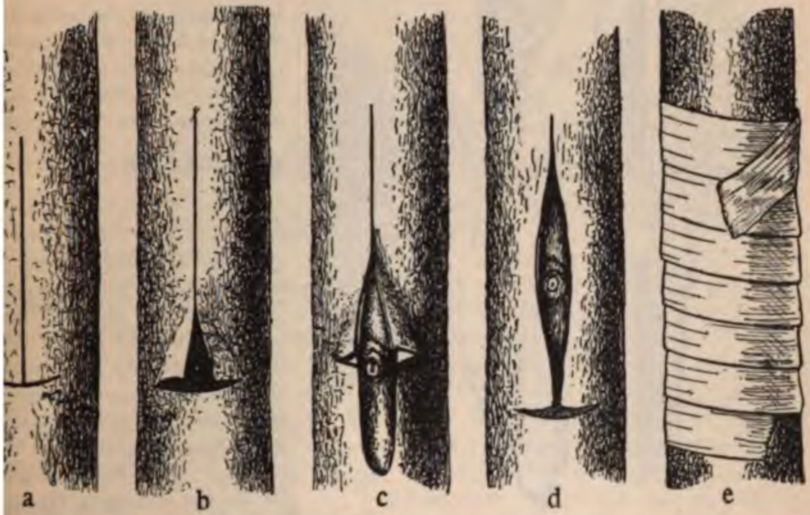
[a] The choice of wrapping material is an individual and a local affair. Some nurserymen use only raffia and have nearly perfect success; other nurserymen use only cotton wrapping twine and their buds take almost perfectly. These are located in the moister sections where buds are not apt to dry out.—P. H. R.

es. Most of the buds are now inserted from 2 to 6 inches above the soil. In ons where foot-rot is abundant and sour-orange stock is used as a preventive sure the buds should be inserted from 12 to 18 inches above the soil, so that the t-orange wood will be above the influence of the disease.

l leaves and limbs which would hinder the proper wrapping of the buds ld be cut away with a sharp budding knife. The use of sharp tools is the secret ccess. A vertical cut about 1½ inches long is made at the point where the bud be inserted. At the base of this a horizontal cut is made, so that the two cuts ent the appearance of an inverted T (⊥), as shown in fig. 13, *a*. The cuts should be deep. The aim should be to merely cut through the bark, but no injury will lt if the cuts are rather deeper. The lower edges of the bark are slightly raised the end of the knife blade (fig. 13, *b*) to facilitate the insertion of the bud. may also be accomplished by giving the knife an upward turn after making orizontal cut. Now, take a stick of bud wood in the left hand and cut out a bud,



13.—Shield, or eye, budding: *a*, incision on stock; *b*, incision with lower ends of bark raised for erting the bud; *c*, bud partially inserted; *d*, bud inserted ready to wrap; *e*, bud wrapped with xed cloth. (From Yearbook U. S. Dept. Agr., 1896.)

lustrated in fig. 12. Formerly the portion of the wood cut out with the bud was oved, but experience has shown that this is entirely unnecessary. The upper of the bud is inserted under the slightly raised ends of the bark (fig. 13, *c*) and ually pushed upward until all portions of the cut face of the bud come in con- with the wood of the stock (fig. 13, *d*). If in proper condition for budding, the of the stock readily separates, allowing the bud to be pushed upward into posi- . The bud is now ready to wrap. Take a strip of the waxed cloth prepared as e, and beginning slightly below the horizontal cut wrap tightly around the k over the bud in a spiral manner, each turn slightly overlapping the previous The wax holds the cloth in place and makes it possible to draw it very tight. en the vertical incision has been entirely covered, turn the end of the strip tly downward over the wrapped portion, to which it adheres more firmly than ould to the bark, and no tying will be necessary (fig. 13, *e*.) It is better to wrap below upward, as in this case each turn overlaps the other in the right direc- to prevent water running down the stem from entering. Nurserymen usually wrap over the bud, covering it entirely. Some, following the practice c used with other fruits, leave the eye of the bud exposed. This, however troublesome and does not succeed so well.

In some cases where bud wood of certain varieties is difficult to secure, i desired to use buds from the young angular wood (fig. 10, b). This may with good results if the stock to be budded is growing rapidly and is in a condition. In this case the method of cutting and inserting the bud is sli ferent from that already described. In cutting the buds the stick is turne to one side, so that as the bud is cut off the eye lies on one side instead center of the bud (fig. 14, a, b, and c). It is only by cutting the bud in that the cut surface is made wide enough to hold the bud firmly in positi inserting these buds an is made in the bark, as fig. 13, a. The bark is raised on one side with t of the knife and the bud i under in a lateral dire eye remaining in the ve (fig. 14, d). The bud wrapped as shown in fig.

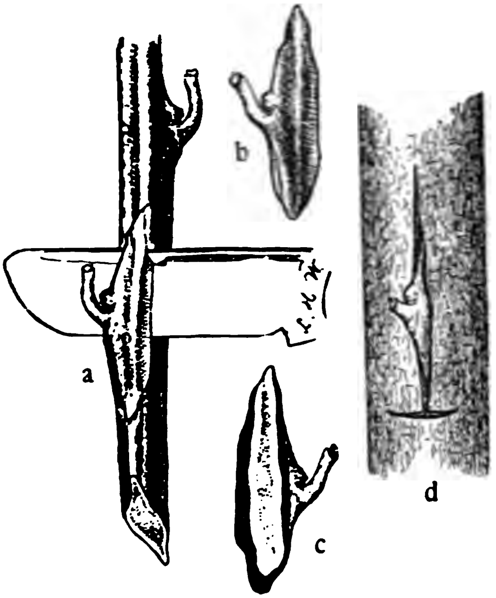


FIG. 14.—Shield budding with angular wood: a, cutting the bud; b, bud cut ready to insert; c, bud showing cut face; d, bud inserted, bark on right side only being raised. (From Yearbook U. S. Dept. Agr., 1896.)

UNWRAPPING THE

In from ten to twelve buds will have united stock and may then be un In early spring, when th is cool and the growth wrapping should be left fifteen to twenty days, the summer when the w warm and the growth r days is usually a sufficie of time. However, it is ble to say definitely h time should elapse b wrapping should be re the wood of the stoc never be allowed to grow buds. It should not be removed until a light grayish line of new tissu seen forming around the edge of the incision made in inserting the bud. experience will enable one to tell at what stage it is safe to unwrap. Un nary conditions from twelve to fifteen days will give good results, but dry weather in the summer, when growth is slow, it may be necessary the wrapping on for a longer time. Some ten days after budding an exa should be made of a number of the buds, and if they are found to be well h the wrapping may be taken off; but if not, the wrapping should be repl allowed to remain some time longer. If the wraps are allowed to re long, the wood of the stock is likely to grow over the buds and greatly hin pushing.

FORCING THE BUDS.

In order to force the buds to push uniformly after they have healed on, i essary to severely check the growth of the stock. This is most commonl plished in nursery trees by lopping the tops, as it is called, which is usua three to five days after the wraps are removed from the buds. The lopping is ly done with pruning scissors, the knife-edge being placed about 2 inches above ud and the stock cut two-thirds through. The top is then bent over to one nd allowed to rest on the ground (fig. 15, *a*).

provide for subsequent cultivation and attention it is necessary to use some te plan of budding and lopping in the nursery. Two methods most commonly ed by Florida nursen are to lop the f two adjoining rows he same center (fig. , keeping the altercenters free for culon, or to lop the tops ernate rows in differrections, one row in center (fig. 16, *b*), lace them near the By the latter od a cultivator may n up one row and the other, passing 's in the direction in the tops are inl so that the branches not interfere with iltivator. Usually the old tops are allowed to remain attached until the buds attained a height of from 12 to 18 inches, after which they may be cut off.

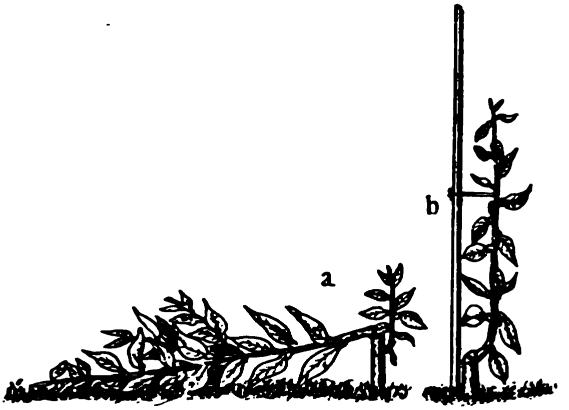
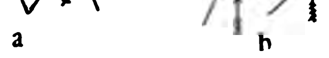


FIG. 15.—Treatment of buds: *a*, young tree lopped to force bud: *b*, bud and supporting stake after "lop" has been removed. From Yearbook U. S. Dept. Agr., 1896.

ne nurserymen have found that the buds make a larger growth if the old tops are allowed to remain attached through the summer and are cut off in September. If this practice is followed, two rows of trees should be lopped together. The tops thus form a dense shade or sort of mulch on the soil, keeping it moist and preventing the weeds from growing. In this case it is also desirable that the rows lopped together should be planted rather close (about 3 feet apart), for if this is not done the weeds will grow up among the tops, making it necessary to cut off the latter when the buds are 1 foot to 18 [illegible] high in order to keep the weeds [illegible]. In the case of vigorously growing stocks, he rough lemon, it is said to be very desirable to leave the tops attached for time.



·.—Diagrams illustrating methods of lopping ery trees: *a*, lopping two rows in one center. ng alternate centers free for cultivation: pping alternate rows in opposite directions. m Yearbook U. S. Dept. Agr., 1896.

ıen the old tops are removed, the portion remaining above the [illegible] ff smooth and close to the bud, so that it will soon heal over with [illegible] gly scar (fig. 15, *b*). Some follow the practice of coating the fresh [illegible] shellac, but others working on an extensive scale never do this [illegible] ıny noticeable benefit is derived from the practice.

GROWTH OF THE BUDS.

The attachment of the rapidly growing bud is at first very weak a[illegible] to strengthen it by tying to a stake (fig. 15, b). Some nurserymen [illegible] the stock rather high in lopping, and support the buds for a time [illegible] the remaining portion of the stock. The buds push much better [illegible] the stocks are cut very close in lopping, so that it is hardly des[illegible] this method of supporting the buds, as in either case it is necessary [illegible] the supporting stakes. (See figs. 15 and 17.)

F[illegible] Arrangement of stakes in a nursery. (From Yearbook U. S. Dept. Agr. [illegible]

The development of the buds should be carefully watched during summer [illegible] they should be pruned in such a way as to produce a top of the desired shape. [illegible] where a low tree is desired, it is necessary to nip the tops when they [illegible] feet high to induce branching. The buds which push low down on the st[illegible] should be rubbed off before they have grown to any size, as their gr[illegible] from the development of the bud.

DORMANT BUDDING.

[illegible] buds which are intended to remain dormant during the winter, or [illegible] as it is called, is usually done in October or November. The pr[illegible] same as described above, except that the tops are allowed to re[illegible] the following spring. They are lopped in the usual manner the la[illegible] February or just before the spring growth starts. The advantage of dor[illegible] to secure the first spring growth in the bud, which is the largest gr[illegible] the year.

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 239.

IE CORROSION OF FENCE WIRE.

BY

ALLERTON S. CUSHMAN,

ASSISTANT DIRECTOR, OFFICE OF PUBLIC ROADS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF PUBLIC ROADS,
Washington, D. C., November 13, 1905.

I have the honor to transmit herewith for publication as a Farmers' Bulletin of this Department a manuscript setting forth the results of an investigation of the corrosion of iron and steel wire used for fencing. So many complaints have reached the Department from time to time that it has seemed urgently necessary to inform the farmers of the country regarding the facts of the case and to bring about, so far as is possible, an improvement in present conditions.

Respectfully,

LOGAN WALLER PAGE, *Director.*

HON. JAMES WILSON,
Secretary of Agriculture.

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FORD UNIVERSITY

THE CORROSION OF FENCE WIRE.

INTRODUCTION.

The investigation of which this bulletin is in part a record has been carried on with a twofold purpose in view. The first object is to furnish information to the farmer which will enable him to exercise an intelligent judgment as to the difficulties involved in the manufacture of wire fencing which shall be low in price and at the same time resistant to rust and corrosion. The second object has been to determine, with the cooperation of progressive manufacturers and metallurgists, the causes which underlie the much too rapid corrosion of modern steel wire, and, if possible, to suggest improvements in methods of manufacture by means of which the difficulties may be at least partially, if not wholly, overcome. There is reason to hope that at least something has been accomplished and that the future will show a substantial improvement in the lasting quality of the galvanized wire turned out by the manufacturers.

The earlier correspondence that was carried on in the effort to get at the facts showed that a great many farmers believe that the manufacturers have neither the intention nor the desire to make the best possible wire. On the other hand, some manufacturers held that, if it were possible to make a higher grade of wire at even a slightly higher cost, it would be useless to attempt it, as the farmer desires cheapness above every other consideration. It is safe to say that neither of these extreme views has been substantiated by the evidence gathered during the progress of this investigation. The majority of farmers in this country know that a fence that will last in good condition for twenty years is cheaper than one that costs one-half as much money and is useless in five years. It is equally true that American manufacturers have for the most part shown themselves not only willing but anxious to contribute in every possible way to the success of the investigation, and have given evidence of their desire to make the best product consistent with their knowledge and the trade conditions that have to be met.

It is frequently asserted that wire for fencing is manufactured from the refuse of the furnaces and the junk piles, and that the metal used in forming the galvanized coating is largely adulterated with metals cheaper than zinc. The first contention shows ignorance of the fact that refuse metal of this kind could never be drawn to the form of wire, and that any manufacturer who followed such methods would speedily find his finished product upon his own junk pile; and as to the second contention it may be said that, if it is true, no indication of the fact has been discovered during the course of the investigation.

It is therefore presumed in this discussion that the farmer desires to purchase fencing that will be good and at the same time as cheap as is consistent with the greatest efficiency and economy, and that the manufacturer is willing to supply this legitimate demand so far as he can.

The real cause of the trouble is a metallurgical problem and requires careful and impartial consideration. This bulletin is an effort to give all the evidence obtainable up to the present time, and also a short, simple description of the modern methods of iron and steel manufacture and of the processes involved in making the wire. It also contains evidence pointing to what may turn out to be the real cause of the trouble and suggestions for possible future improvement. Highly technical discussion and purely scientific suggestions have been put into an appendix for the consideration of those who are likely to be interested in them.

For some time past numerous complaints from different sources have reached the Department concerning the inferior lasting quality of the steel-wire fencing which is to be found in the market at the present time. Among the various statements of fact and explanations which have been advanced, whether supported by sufficient evidence or not, the following may be cited to show the necessity for a thorough investigation of the subject in all its bearings:

(1) That, while the older wire, purchased twenty or more years ago, is frequently found still in good condition, modern wire goes to pieces in from two to five years.

(2) That iron wire resists oxidation better, and therefore is more durable than steel wire.

(3) That the entire difficulty lies in the use of Bessemer steel, and that puddled iron is far better suited to the purpose.

(4) That heavier weight wire was used in the older product, and hence its lasting quality.

(5) That the trouble is wholly caused by the inferior weight and quality of the modern galvanized coating, and that the character of the metal itself has nothing to do with it.

(6) That in order to cheapen the product lead and other adulterants are added to the zinc spelter bath used in making the galvanized coating, and that the methods in use at present are in general inferior to the older methods.

(7) That the manufacturers do not desire to make a resistant wire, but prefer a product that will require frequent renewal.

(8) That the majority of farmers and other consumers prefer cheapness to any other consideration, and that if a better product can be manufactured for a higher price there will be little or no market for it.

(9) That the whole agitation is ridiculous and unnecessary, as better wire is now being manufactured than ever before, and that the whole trouble lies in the greater amount of coal that is at present consumed, leading to an increase of corroding gases in the atmosphere.

(10) That the manufacturers are aware that all is not right and are anxious to do all in their power to improve the durability of their product.

While some of these claims may be considered extreme, they also contain much that is true and worthy of careful investigation. At all events, a very large amount of evidence can easily be obtained to show the truth of the original contention that the older iron wire is much more durable than modern steel wire.

In order to collect all the information possible, a circular letter containing a number of questions bearing upon the subject was sent to the leading manufacturers in the country. Space will not allow all the answers obtained to be published, but the questions, with the answers received from two of the largest manufacturers in the country (here designated as A and B), are inserted:

(1) Is the wire manufactured by you for fencing classed as iron, mild steel, or steel?

A. Steel and mild (soft) steel.

B. Our fencing wire is classed as steel.

(2) In case more than one kind or brand of wire is manufactured by you, do these all fall into one class as defined in question 1?

A. No. Steel produces a relatively stiff wire of high tensile strength; mild or soft steel produces softer wire of less tensile strength.

B. All fence wire is classed as steel. Telephone wire in different grades is classed as both iron and steel.

(3) Do you classify wire as iron, mild steel, or steel, according to the original process of manufacture, or according to the amount and condition of the carbon content?

A. According to the carbon content.

B. We have three classifications, and these are based mainly according to the amount and condition of the carbon content.

(4) What is the original process of manufacture of the metal from which your wire is drawn, viz, Bessemer, open-hearth, etc.?

A. Bessemer and open-hearth.

B. Steel, Bessemer or open-hearth Bessemer equivalent; B. B. iron, low carbon open-hearth basic steel; E. B. B. iron, genuine Swedish charcoal iron.

(5) What system of annealing do you follow?

A. Either through molten lead at a red heat or through fire brick tubes at a red heat.

B. Fence wire is annealed by the lead process; telephone wire is annealed by the tubular furnace process.

(6) In case of galvanized wire or wire otherwise coated with a metallic protective coating, what method of pickling is followed? If an acid is used, what

acid, and of what strength? Is the wire thoroughly washed after leaving the pickling bath?

A. Muriatic acid is used, of a strength equal to 10° Baumé. The wire is thoroughly washed after leaving the pickling bath.

B. Muriatic acid (18°) is used for pickling, which is not washed off; the wire passes directly into the zinc bath. The muriatic acid solution is intended to act as a soldering solution.

(7) In the case of galvanized wire, what metal or mixture of metals is used to produce the protective coating?

A. Pure commercial zinc.

B. For fence wire, prime western spelter is used; for telephone wire, high-grade spelter made from pure zinc oxide.

(8) What weight of the protective coating for a unit weight of wire do you aim to cover with?

A. From 2½ to 3½ per cent.

B. Fence wire, 80 to 90 pounds of zinc per 1 ton of wire; telephone wire, 140 to 150 pounds of zinc per 1 ton of wire.

(9) At what temperature is the bath maintained in which the galvanizing process is carried on?

A. 800° to 850° F.

B. The temperature of the zinc bath is maintained at a sufficiently high point to keep the metal in a uniform flowing condition.

(10) Is it your opinion that a more durable and resistant wire could be manufactured if the trade conditions permitted a reasonably higher price being asked for it?

A. We manufacture the best wire we know how to produce.

B. Yes.

(11) Would you be willing to write us a letter containing your experience in regard to the accompanying five statements?

I. That modern steel wire corrodes more rapidly than the older wire that was found in the market, say, from ten to twenty years ago.

II. That this older wire retains its galvanized cover better than the steel wire now produced.

III. That the galvanizing processes are not in every case as efficient as they could be made.

IV. That the degree of tension under which the wire is hung may have an effect upon the life of the protective coating.

V. That the action of certain gases in the atmosphere which result from the consumption of coal exerts an influence upon the durability of fence wire.

A. We submit the following answers:

I. Modern steel wire is better and more uniform, and can be made more uniformly soft to-day than it could be made ten or twenty years ago. We are unable to discover that steel wire corrodes more rapidly. We are convinced, however, that iron wire, when galvanized with zinc, resists corrosion more perfectly than steel wire.

II. The fence wire we are making to-day is superior to that made ten and twenty years ago. The spelter is more uniformly applied and the coating heavier, and, as we are manufacturers of our own spelter, its quality is maintained more uniform.

III. Our galvanizing processes have been improved from year to year, and the uniform quality of the wire produced is very good.

IV. In our opinion the tension under which the wire is hung has no effect whatever on the life of the protective coating.

V. Around chemical works, wire mills, etc., where acid fumes are in the air and are absorbed or where other factories, as well as railroads, are located which contaminate the atmosphere with large quantities of coal smoke, conditions are very destructive to zinc covering. This is more especially true in districts where fuel containing large percentages of sulphur is used. This pollution of the atmosphere to-day is much more severe on zinc-coated wire than twenty years ago.

B. We will be very glad indeed to assist the Department of Agriculture in any way possible, and if we can serve you, command us.

(12) Are you willing to supply the Division of Tests with test samples of your various brands of wire?

A and *B.* Yes.

It will be seen from the above that while one of these correspondents believes that his company is making the best wire possible, the other admits that better wire could be used for fencing if the price permitted. There is no question but that the higher-priced wire that is manufactured for telegraphic purposes is more durable than that used for fencing, and the reasons for this will be developed in the course of this paper.

MANUFACTURE OF IRON AND STEEL.

Before the farmer or any other user of steel wire can intelligently consider the problem of the corrosion and deterioration of iron and steel it is necessary that he should be to some extent familiar with the methods of manufacture, the system of classification, and some of the effects of the ordinary impurities.

Iron as it is manufactured from its ores is never pure, nor would perfectly pure iron be suitable for the various purposes for which the metal is used. Iron is found in nature combined with oxygen in the form of an oxide, in which it occurs in great reddish-brown or bluish rock-like deposits known as hematite and limonite. There are several oxides of iron which differ from each other in the relative amount of oxygen which is combined with the iron. The ordinary red oxide which forms when iron rusts is essentially the same oxide that occurs in nature as hematite ore.

HOW CAST IRON IS PRODUCED.

In rusting, oxygen is added to the iron, and in smelting the ore, oxygen has to be taken away from the iron. To do this, ore is mixed with coke and limestone and heated in large furnaces so arranged that a blast of hot air can be forced in through suitable holes near the bottom. Air consists mainly of a mixture of oxygen and nitrogen gases and at the high temperature of the blast furnace a great many things happen. Coke is almost pure carbon and when it burns in the furnace it not only combines with all of the oxygen of the air but also takes away all of the oxygen which was combined with the iron in the ore, passing out of the stack in the form of gases. The metallic iron is thus set free in a liquid or molten condition, in which it falls to the bottom, or hearth, of the furnace.

Now, however, we come to an important point. Carbon is very soluble in molten iron, and as more than enough carbon to combine with the oxygen is always present the molten metal is really a solution of carbon in iron. This simply means that the carbon goes into the iron just as sugar or salt will pass into water. At definite times the molten metal is allowed to run out of the tap hole of the furnace into a series of sand molds which is known as the pig bed. There the iron cools more or less rapidly, but as it cools another very important thing happens—part of the dissolved carbon crystallizes out into hard crystals of solid carbon as the mass takes on the solid condition, while the rest of the carbon remains in the iron and does not crystallize out. The carbon which does not crystallize out is now believed to be in part combined with the iron and in part held in a state known scientifically as "solid solution," but by the iron metallurgist it is spoken of as "combined carbon." The crystalline carbon is far more like black diamond than it is like the soft, greasy variety of carbon known as graphite, from which lead pencils are made, and yet the iron metallurgist has come to speak of this free carbon in his metal as "graphitic."

Besides carbon, the molten iron either dissolves or combines with several other substances that are of the very greatest importance in the metallurgy of iron. These are sulphur, phosphorus, silicon, and manganese. All these so-called elements are introduced into the furnace, not necessarily on purpose, but as impurities in the ore, coke, and limestone; and, while, if not properly controlled, they become very harmful, some of them, like carbon and silicon, are absolutely necessary to the proper working of the iron.

Pig iron is the crude form of iron, the raw material for the manufacture of all the finished grades of iron and steel. When simply melted up in a reheating or cupola furnace and cast into shapes, such as car wheels, a good iron may have the following analysis:

	Per cent.		Per cent
Total carbon	3.50	Manganese	0.40
Graphitic carbon	2.90	Phosphorus	.50
Combined carbon	.60	Sulphur	.08
Silicon	.70		

As is well known, cast iron can not be forged into shapes or drawn into wire, on account of its crystalline granular structure. In order to render iron suitable for working in this way, it must be changed by some process into what is known as wrought iron or into steel.

We are now in a position to consider briefly what is meant by expression (so frequently used in relation to wire problems) such as Bessemer steel, basic open-hearth steel, puddled iron, and mild and high-carbon steel. In the simplest language, the whole process of converting cast iron into a workable metal, by whatever name it may be known, consists in remelting the metal in the presence of a great excess of hot air, so that nearly all, though usually not quite all, of the carbon is burned away, while in some of the processes certain of the other impurities already mentioned are more or less completely removed.

THE BESSEMER PROCESS.

The Bessemer process is the great modern method for converting iron into steel, and on account of its simplicity of operation and the large amounts of metal that can be worked at each charge, it has not only been of the greatest benefit to the iron industry, but, by making steel cheap, has produced a wonderful effect upon the progress of civilization. The only question in the minds of thoughtful metallurgists to-day is whether it has not been overdone and whether, indeed, it is best suited for the manufacture of metal that is destined to be drawn into wire or rolled into thin sheets. An expert discussion of this question will be found in the Appendix (pages 25–30).

Described briefly, the Bessemer process consists of pouring molten cast iron into a large pear-shaped vessel called a "converter," furnished with a number of small holes in the bottom through which a blast of air is forced under high pressure. By this means the carbon is nearly all burned out, together with the silicon. The iron, too, is slightly burned, and after the blow is over a certain amount of manganese, in the form of lumps of an alloy or combination of manganese and iron known as ferro-manganese, is thrown into the converter before the metal is poured into the molds to cool. These cooled blocks of steel are known as "ingots." This addition of manganese is a very important point in the metallurgy of steel, and, as we shall have occasion in this paper to return to it frequently, it is necessary that the various reasons for the operation should be understood.

(1) If the molten metal were to be immediately poured after the blow, it would be found on cooling to be full of cavities known as "blow holes," caused by the retention in the metal of gases from the air blast, and would be quite unfit for any purpose whatever. For reasons which it is not necessary to explain here, the action of even the small amount of manganese that is added is almost magical in its effect. The burned iron is again reduced or deoxidized, the mass of metal becomes more perfectly fluid, the gases escape, and the metal pours smoothly and evenly. In other words, the manganese acts as a so-called "flux."

(2) Just as small quantities of carbon dissolved in iron change and modify its properties, so small quantities of other substances produce their own effects. Manganese is supposed to decrease the danger of

breaking up as the metal passes hot through the rolls in the "rod mills."

It is now apparent that manganese plays an important rôle in the Bessemer process, and, in fact, Bessemer steel will generally be found to contain anywhere from 0.4 to 1 per cent of manganese.

BASIC OPEN-HEARTH PROCESS.

Phosphorus and sulphur both have a deleterious effect upon steel. reducing the ductility and making the metal brittle. In a process like the one just described, it is necessary to specify that the pig iron shall contain below a certain percentage of phosphorus. This would. of course, exclude much of the pig iron that is manufactured, as phosphorus in some of its combinations is almost always found in iron ore. By making the lining of the furnace out of a material that will combine with elements like phosphorus, which easily combines with oxygen to form phosphoric acid, much of this impurity may be made to combine with the furnace lining and to remove itself from the metal by entering the slag floating on top of the molten mass. Without going further into the chemistry of the subject, this is all that is meant by basic open-hearth steel, namely, that the pig iron is melted in large basin-shaped furnaces in which the carbon is burned out by the play of hot air over the surface of the molten mass, while at the same time the acid-forming impurities, such as phosphorus and silicon, are absorbed by the basic lining of the furnace, which is usually made of a rock material found in nature, consisting of carbonate of lime and magnesia, and known as "dolomite." Lime or limestone is also added to hasten this action and save the lining. With the exception that the hot air is not blown through the molten metal, the open-hearth process is much like the Bessemer. At the end of the run ferro-manganese is thrown into the liquid bath of metal to flux it. This is done sometimes in the furnace and sometimes in a ladle into which the metal is tapped. It is then run off into the ingot molds to cool in the usual way. It will be noted that the open-hearth process depends essentially, as does the Bessemer, upon refluxing with manganese.

PUDDLED IRON.

It only remains now to outline briefly the older puddling method by which wrought iron was made, which yielded most of the extremely durable wire that was found in the market many years ago. This process consists essentially of heating the iron in flat-shaped urnaces to a more or less fluid or pasty condition and then working over and over in the presence of air by means of special tools known s "rabbles," in the hands of skilled workmen. By this means the impurities are oxidized and burnt off, and the slag or cinder which always forms is worked into the metal, so that when it comes to be rolled not only are the impurities very evenly distributed throughout the mass, but it possesses the structure of a bundle of fibers, each one of which is coated with a film of cinder, which protects it in very large measure from subsequent rusting. This cinder is composed of oxide of iron combined with silica, which comes from the fire-clay lining of the furnace, for in this process basic linings are not used.

In the minds of most metallurgists some sort of return to this older method would be the best solution of the problem of the manufacture of wire which would resist oxidation, but the trouble lies in the impossibility of competing with the price of metal manufactured by the more economical modern processes. It must be apparent to everyone that the high price of labor would not permit hand-worked metal to compete on a large scale with that produced by modern methods. It has, however, been proposed to use a form of mechanical puddling which would be capable of treating at one time charges of metal as large as those used in the Bessemer process. It is not impossible that eventually this will furnish a solution of the difficulty.

It may be added that Swedish charcoal iron is a modified form of wrought iron, in which the impurities run very low. At the present time no charcoal iron is manufactured in this country for fence wire.

MILD AND HIGH-CARBON STEELS.

As has already been pointed out, steel is to be considered as an alloy or solution in varying proportions of carbon in iron. It may now be said that within certain limits the higher the carbon content the harder the steel. Mild steel is that in which the carbon rarely runs above 0.1 to 0.2 per cent, while in hard steel the carbon may run as high as 1 per cent or even higher.

The following analyses may be taken as fairly typical of the various kinds of metal we have been discussing, although these figures may of course vary widely with the different degrees of hardness that the manufacturer desires to obtain:

Constituents.	Bessemer steel.	Basic [a] open-hearth steel	Swedish puddled iron.
	Per cent.	*Per cent.*	*Per cent.*
Carbon	0.10	0.70	0.04
Manganese	.50	.50	.06
Sulphur	.08	.06	.01
Phosphorus	.102	.05	.01

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[a] Open-hearth metal may run much lower in carbon and much higher in manganese than these figures indicate. Some samples which have been received ran as high as 1.5 per cent manganese.

The presence of these various impurities complicates the difficulty in tracing the trouble to any one element. In some grades of wire it is said to be a positive advantage to have high phosphorus and silicon, but in fence-wire stock these elements are present in comparatively small quantity, while the carbon and manganese run high. It will be noticed that the amount of impurities in the Swedish iron is extremely small.

MANUFACTURE OF WIRE.

Having now described briefly the various kinds of metal used in the manufacture of wire, it will be necessary to explain the methods of wire making, or such as apply to the sort of wire that is used for fencing.

The ingots already described, after cooling in the molds, are reheated to a bright red heat, rolled down, and cut into lengths of a certain shape and size, known as "billets." Most wire-fence manufacturers buy either their wire or their billets from the steel mills, and comparatively few make their own steel. The horizontal heavy wires of a woven fence are usually made from a fairly high-carbon hard steel in order to attain great tensile strength or resistance to breaking under strain. The vertical or tie wires must of course bend easily without breaking, and they are made from a mild or soft steel, usually Bessemer metal. All metal used for fence wire at present made in this country is classed as steel, irrespective of the percentage of carbon or whether made by the Bessemer or open-hearth process. The billets are rolled hot into No. 5 gauge wire rod. This is then pickled in sulphuric acid until clean, then soaked in hot limewater to remove the acid, and baked for about half a day, when it is drawn cold through dies of hard steel to the required gauge, usually No. 12. The lime coating on the wire lubricates it and prevents it from cutting out the dies. The wire is now ready for galvanizing, which consists of running it through brick tubes or ovens which are heated by coal or gas, where the process of annealing or softening takes place. When the wire is cool enough it enters a bath of acid, which cleans it and removes any scales that may have formed during the process of annealing. This so-called "pickle" consists of diluted muriatic acid and is a necessary treatment, as the wire would not take the zinc unless it had first been through the acid bath. The question as to whether the acid should be washed from the wire before it enters the zinc bath is important and manufacturers seem to differ in their practice. It is by no means certain that acid included in the zinc and under it will not tend to corrode the metal rapidly. Some sort of chloride is undoubtedly necessary to make the iron take the zinc, but it is natural to suppose that the presence of actual acid should be avoided.

The wire is next run into a vessel about 16 feet long containing melted zinc. As the wire emerges from the zinc bath it is run through asbestos wipers, which wipe off nearly all of the zinc and leave a smooth coating, which amounts usually to about 1 to 1½ per cent of the wire. The discussion of the method of galvanizing will be reserved for a separate section; it is sufficient to point out at this place that the coating of zinc furnished by this single process is very thin, and therefore presumably more perishable than a thicker coating would be. After the wire is galvanized, if a woven-wire fence is to be made, it goes to the weaving room, where the finished product is turned out. In some cases, especially in the manufacture of fine wire fencing, such as poultry mesh, the galvanizing is done after the weaving.

INVESTIGATION OF THE CAUSES OF FENCE-WIRE CORROSION.

Having now followed the processes of the manufacture of steel-wire fencing from the ore to the finished product, we are in a position to consider intelligently the information that has been obtained by means of a rather long and detailed investigation.

EXAMINATION OF SAMPLES OF WIRE.

Evidently the first thing to be done was to prove beyond all doubt that the older wire, as claimed, did outlast modern steel wire; and secondly, to determine, if possible, the reason for this. A large number of letters were received from all over the country in response to official inquiry, and all pointed in the same direction. As far as human testimony is capable of establishing a fact, there need be not the slightest question that modern steel does not serve the purpose as well as the older metal manufactured twenty or more years ago.

A great number of samples of wire were sent to the Division of Tests, and a series of analyses were made to see whether chemical analysis would throw any light upon the subject. In a paper of this kind it is not desirable to go too deeply into scientific and technical details, and therefore no tabulated results of analyses will be given. It is sufficient for our present purpose to state that it soon became noticeable that the majority of the old wires sent in which were in good condition were either free from manganese or contained only very small amounts—0.2 per cent or under of this metal. It is true that many of the good wires ran as high as 0.5 per cent and even higher in manganese, but the fact was nevertheless noticeable that the bad wires, with very few exceptions, contained manganese, while the good wires were frequently if not always free from it.

MANGANESE CONTENT OF STEEL AS AFFECTING OXIDATION.

The results of these preliminary experiments pointed undoubtedly to manganese as having something to do with the matter. The great difficulty was in explaining the exceptions. After a great deal of experimental work had been done in the chemical laboratory, however, one possible explanation appeared that might account for the facts obtained. Manganese dissolved in iron up to a certain percentage is known to increase the electric resistance of the metal. This means that iron wire containing manganese will resist the passage of electricity through it to a greater extent than a wire that contains little or no manganese. In case the manganese were not dissolved or mixed with perfect uniformity throughout the iron, electrical currents might be generated in the wire when wet, which would lead to rapid corrosion, as will be explained later. In order to get a practical opinion as to whether manganese was thought to have anything to do with the lasting quality of steel, the president and general manager of a company which is an enormous consumer of wire was appealed to, with the result that the following opinions which had been formed as the result of practical experience were received:

I. Bessemer or mild steel wire will rust or deteriorate much more rapidly than iron wire, in all probability three times as rapidly, although this is only an approximation.

II. The more manganese there is present the shorter will be the life of the metal.

III. In soft steel the manganese will reduce the conductivity of the wire fully 50 per cent below the conductivity of wire containing only a trace of manganese.

It seemed from this that, before the laboratory investigation instituted by the Department of Agriculture had been made, practical experience had indicated that manganese was at the bottom of the trouble. In order to show that there was still more authoritative evidence pointing in the same direction, it will be necessary to quote from a paper, by Mr. James P. Roe, on the "Manufacture and characteristics of wrought (puddled) iron," which was presented before the Washington meeting of the American Institute of Mining Engineers in May, 1905. The author says:

> That wrought iron resists oxidation better than steel is becoming the general opinion of those who have studied the question under actual working conditions. The difference is naturally more apparent in thin objects, such as corrugated roof sheeting, tin plate for roofing, and the like; but its influence is the same regardless of mass. The difference in the life of light sections is about as 5 to 1 in favor of puddled iron.
>
> The explanation of this resistance to oxidation is twofold:
>
> (1) The cinder, a ferrous iron silicate enveloping each fiber, is much atten-

ated by rolling, and in that condition is elastic. A piece of iron fresh from the rolls is covered with relatively thick scale, which will readily crack off to a large extent, exposing a surface of iron fibers with its intervening cinder. These fibers oxidize somewhat rapidly, leaving a finely corrugated surface of cinder, which resists further atmospheric action, as may be seen in heaps of scoriæ from old hearths believed to date from before the Christian era. Being elastic, it resists for considerable though varying periods; but eventually it cracks off under vibration, expansion and contraction, or mechanical wear. The cycle is then repeated, and so on.

(2) Puddled iron is a mechanical combination of two substances, iron and cinder, which offer differing resistances to such pressure as that of rolls or hammers. The result is a rough surface, which forms a more lasting bond with any protecting agent, such as tin or paint, than the smooth surface of steel, which does not aid in any way the adhesive qualities of the protecting agent.

In connection with the question of oxidation I may instance the experience of a large tube works carrying a considerable stock of iron tubes and accustomed to take from and add to the top of the stock pile without regard to the tubes in its lower part, knowing that these, when ultimately reached, would be found to be corroded uniformly over their whole surface, but could be rerolled to a lighter gauge, producing perfect tubes. After beginning to make steel tubes they followed the same practice; but these tubes were found, after rerolling, to be pitted through, and therefore valueless.

I am indebted to Doctor Raymond, secretary of the Institute, for the suggestion contained in the following communication:

> In preparing your paper for the press I notice that you have omitted to mention, in connection with the question of the more rapid oxidation of soft steel, a chemical reason, namely, the presence of manganese in the metal. Many years ago, as consulting engineer of the firm of Cooper, Hewitt & Co., I approved the substitution of low-carbon steel for wrought iron for certain articles of manufacture. The immediate result was complaint from both consumers and selling agents that these articles rusted so soon as to look old, even upon delivery. A careful investigation, conducted for the firm by the late Dr. T. M. Drown, located the source of this trouble in the manganese of the low steel, or "ingot iron." In that particular case the rapid surface corrosion probably did not affect the real usefulness of the articles. But it may easily be inferred that when a coating of tin, zinc, or paint is applied to a sheet of metal a very slight extra liability to oxidation in that metal may set up a series of chemical and galvanic reactions of destructive character.
>
> I have had recent occasion to realize with surprise and consternation the imperative necessity of frequent repairs to roofs, pipes, etc., of tinned or galvanized iron. My trusted mechanic declares that all his customers are similarly affected, and protests that he can no longer obtain anywhere materials of this class as durable as they used to be. He thinks that something is the matter with the processes of coating with tin or zinc; but I shrewdly suspect that the trouble lies in the manganese of the metal coated and in the series of reactions which its easy oxidation initiates.
>
> It seems to me that the "pitting" of steel to which you refer is directly due to manganese.

As a final bit of evidence a quotation from a letter will be included which was received from Henry M. Howe, an experienced metallurgist, and the author of several well-known books on iron and steel:

> Under certain conditions—for instance, in the case of boiler tubes—there appears to be little doubt that Bessemer steel of quality very similar to that which is rolled out for wire apparently does rust more easily than wrought iron suitable for such wire. Three reasons may be assigned:

(1) The wrought iron contains a small quantity of slag or cinder through it, which may mechanically protect the iron from corrosion, the sheets of cinder acting like so much paint to keep the atmospheric oxygen away.

(2) In order to make this steel very soft, so that it will draw easily, it is likely to contain a quantity of blowholes, which form centers from which rusting begins.

(3) The steel contains much more manganese than wrought iron does, and this manganese may not always be distributed with absolute uniformity. Wherever there is the least lack of uniformity there is a difference of potential, which may lead to rusting.

With this evidence we may rest the case and safely accept, at least for the time being, the following two points:

(1) That modern Bessemer and open-hearth steel rusts much more rapidly than iron wire.

(2) That manganese, especially if it is unevenly distributed in the steel, is at least in part the cause of the trouble.

ELECTROLYSIS AND ITS EFFECTS ON WIRE.

In order to pursue the inquiry further it will be necessary to show just how the manganese can have the bad effect that it does. Nearly everybody has probably heard at some time that steel pipes and conduits are liable to corrosion, owing to electrolysis or galvanic action. As a word this may be satisfactory, but unless the exact character of the action which it describes is understood it is a very unsatisfactory explanation. If this paper were to sum up the whole investigation by saying there is reason to believe that the cause of the rapid deterioration of steel fence wire has been traced to electrolysis induced by unequal distribution of manganese or other impurities, perhaps some readers might justly complain of being little wiser than before. It is necessary, therefore, to define as simply as possible "electrolysis," "difference of potential," and several other terms which will be used in this discussion before proceeding further.

If we wish to generate in a house small currents of electricity with which to ring an electric bell it is necessary to purchase or make a simple form of electrical cell or battery. Reduced to its simplest terms, this usually consists of a strip of zinc and a strip of some other metal immersed in a more or less dilute solution of some salt. Common table salt would do, but for special reasons some other soluble salt, like chloride of ammonia, is usually selected. If now by means of a wire or other metallic conductor the zinc strip is connected with the other metal, an electric current flows through the circuit. Whenever this is able to happen, we say that there is a difference of potential between the zinc and the other metal. In general, whenever a difference of potential is established between two points in a metallic conductor or circuit a current of electricity will flow. If in the case of the battery referred to, the current is allowed to flow through an especially constructed electro-magnet, it can be caused to ring a bell. In the same way if the current were strong enough it could be used to saw wood or to run a street car. In other words, electric currents, however small, represent energy and can be made to do work.

There is a great and well-known law of nature which tells us that it is impossible to get something for nothing. If work is being done in one place, something is being, so to speak, undone in another place to balance it exactly. Every person who climbs upon a street car pays a fare which represents, at least in some degree, the cost of the coal or carbon which has to be burned (oxidized) at the power house in order to move him. Every time the bell rings in the house the zinc in the battery is corroded or oxidized or burned up to represent the work done. Whenever, through the agency of a liquid conductor like a salt solution, a current of electricity moves in a circuit, this is known as electrolysis. Whenever electrolysis goes on, some chemical reaction takes place, which, for all practical purposes, can be likened to the oxidation or burning of some metal. If a battery were to be made, as could easily be done, in which iron took the place of zinc, then iron would be oxidized instead of zinc. If two pieces of iron of different chemical analysis—that is to say, containing different amounts of impurities—are dipped into a dilute solution of salt and the ends connected, it will be found that a difference of potential exists, an electrical current will flow, and, if continued, at least one of the iron pieces will be destroyed by oxidation. With this simple explanation of electrolysis in mind we may return to the consideration of the oxidation of iron and steel.

The tendency of iron and steel to rust or oxidize is a characteristic of the metal itself, independent of the presence of any impurities it may contain. No iron has ever been or ever could be manufactured that would not rust in moist air, unless it were protected by some sort of covering. There is, however, a very great variability in the way different irons rust. One will cover itself over with a superficial layer of oxide, which will then act as a coating protecting the metal for many years, while another will pit so badly that the corrosion eats to the heart of the metal in a short time. Samples of wrought-iron cut nails that had been exposed to the weather for forty years were sent to the laboratory and found to be in as good condition as the day they were bought, while samples of steel wire 4 years old, which were originally galvanized, have been received which were pitted to the breaking point. Our problem, therefore, is not to find a kind of iron that will not rust, but to determine the causes which lead to the kind of rusting which makes wire short-lived, whether it is furnished with a protective coating or not; and further than this, to see if there is not some way in which we may eventually be in a position to insist upon specifications for steel wire that will be reasonably resistant.

Wire that is hung in the field is in just the condition to suffer from electrolysis if the metal is not perfectly homogeneous in structure; that is to say, if the manganese and other impurities are not perfectly distributed throughout the metal. All rain water contains small amounts of salts dissolved from the dust in the air, and is therefore a conductor of electricity. Water collected during a thunder shower is particularly rich in substances that conduct electricity, as the sparking of the lightning through moist air forms small quantities of nitric acid, and acids conduct electrical currents even better than salt solutions. A moment's thought will show that under the conditions cited we have all the elements present to cause electrolysis to take place. Differences of potential will occur in the wire, local circuits will be established through the wires or through the wires and ground, and currents will flow. Just as in the case of the bell battery, these currents can only be generated at the expense of something, and in this case it is the iron if it is not the zinc of the galvanized covering. This explanation is capable of accounting for the deep pitting observed in the corrosion of many wires, this pitting being characteristic of electrolytic action. It also accounts for the much more rapid corrosion of wire near the seashore, as the rain water in such a locality contains more salt and thus this action is hastened.

If manganese is unevenly distributed in the metal, why, it may be asked, have chemists generally failed to notice the fact in the course of large numbers of duplicate analyses that have so frequently been made? The answer to this question lies in the fact that such extremely small differences in the chemical composition as might easily escape detection in ordinary chemical analysis are still sufficiently large to account for slight differences of electrical potential. It is almost impossible to select two steel needles from the same package which, if tested against one another with sufficiently delicate electrical measuring instruments, will not show a difference, even though the chemical composition appears to be practically the same. Metallurgists claim that even when a molten bath of metal is very evenly mixed in the beginning the cooled ingot made from this metal will show a certain amount of unevenness, owing to what is technically known as "segregation," which takes place while the ingot is cooling. A recent investigator has claimed that manganese segregates much less than some of the other impurities, notably sulphur and phosphorus. So little is definitely known about this subject as yet, however, that more experimental evidence is necessary.

Although it is probable that the effects of electrolysis in a fence wire are extremely small, it must be remembered that they are coninually going on whenever the wire is wet. While it is true that uddled iron is in large measure protected from corrosion by the resence in its fibres of mill cinder, this has nothing to do with the act that in almost all modern steel woven-wire fences some wires will e found to far outlast others, independent of the original weight f the galvanized covering which they carry. If in woven wire ence all the wires would last as well as the best ones do, there would ave been no complaints, and this investigation would never have ecome necessary. It is just this point of unevenness of lasting uality in wires from successive heats in the same mill, which have ractically the same chemical composition, that is hard to explain y any theory but that of galvanic or electrolytic action. The manufacturers have believed that the whole trouble was in the unevenness n the weight of zinc covering that was put on the wire, but experinent and observations show that this is not so. Some wires will go to pieces before others, although there is no discernible difference either n the weight or quality of the zinc covering. In one fence which has been under observation for four years one wire was in perfect condition, although it carried a light covering of zinc, while the wire next to it was badly rusted from end to end. Careful chemical analyses were made of these two wires, and, in order to check the results secured, samples were sent to one of the most eminent iron chemists in the country. This chemist reported as follows:

We have examined these samples, finding as follows:

Constituents.	Good wire.	Bad wire.
	Per cent.	*Per cent.*
Carbon	0.17	0.17
Manganese	.45	.53
Phosphorus	.082	.096
Silicon	.070	.060
Sulphur	.059	.068

You will note that, so far as these two samples go, there is very little difference in the wire, and practically no explanation chemically as to why one should be good and the other bad. They might almost be from consecutive heats from the same Bessemer converter; I do not think they are from the same heat. Notwithstanding this similarity of analysis of the samples which we have examined, it is more than probable that there may be quite unequal distribution of he manganese in the two samples.

It would seem that the easiest way to prove once and for all whether unequal distribution of the impurities is at the bottom of the rouble would be to make a great number of analyses of samples aken from different parts of just such wires as these. Unfortunately, however, the slight but unavoidable errors of chemical analyis are apt to be as large, if not larger, than the slight differences are trying to detect. It is also probable that the problem is complicated by the variation of more than one element. For instance, the combination of manganese and sulphur is known to show a larger difference of potential to iron than manganese alone. It would be natural to suppose that the easiest way to correct the trouble would be to cut down, in the process of manufacture, as much as possible the impurities that are present, but the difficulties in the way of doing this will now be understood.

Leaving the subject of laboratory investigations, we may now turn to the result of observation in the field. Almost everyone who has taken the pains carefully to inspect woven-wire fence as it is exposed to the weather on the farm has observed that some of the wires go to pieces much more rapidly than others. The bottom wires lying close to the ground, which are kept wet in summer by the growth of weeds and grass and in winter by melting snow, are naturally the ones which we should expect to rust most quickly. As a matter of fact, however, they almost never do so, but on the contrary are far more lasting than the wires farther removed from the ground. This observation has been substantiated by a large number of competent observers. Furthermore, wires that are stapled to living trees will almost invariably be preserved to some extent in the immediate neighborhood of the point of contact. One explanation that has been offered for these undoubted facts is that a certain protection from wind and weather is furnished by the growth about the wires, but this explanation is far from satisfactory. One would not seek to preserve iron from rust or zinc from corrosion by laying these metals away in wet snow or weeds. If, however, electrolysis takes place, and if the action can be diminished by keeping the wires electrically neutral through frequent connections to the earth, or through frequent short circuits, we should then expect that wires which were kept along their whole length in constant contact with the earth would, in the long run, show greater lasting quality. Experiments are at present being made to test the effect of earthing the fence by frequent connection to the ground. It is not easy to carry on a discussion of this highly technical subject in a paper of this nature, and it must be left for future presentation elsewhere.

THE PROCESS OF GALVANIZING WIRE.

The consideration of the protective effect of covering wire with a coating of zinc has been purposely put off up to this point. Why, it may be asked, does the quality of the steel make any difference, if it is to be covered with a protective coating of zinc? The answer is simple. It is extremely unlikely that any coating is sufficiently waterproof or sufficiently elastic not to develop numerous cracks and open ings through which water can act and electrolysis begin. Once begun, the electrolytic action corrodes zinc even more rapidly than it does steel. This may explain the very rapid disappearance of the galvanized covering from some wires and its great tenacity on others.

It will now be necessary to explain briefly the methods and practice of covering wire with zinc. In the first place, the word "galvanizng" as used gives a wrong impression. It is possible to dissolve zinc in an acid and then by means of a galvanic current, by the very principles of electrolysis properly controlled that we have been discussing, to deposit it as a coating upon another metal like iron. It has been shown that this method will give the most adhesive coating of zinc upon iron that it is possible to obtain. When we think, however, of the large amount of wire fencing made and the price for which it must be sold, one might as well consider plating it with gold as to suppose that fence wire is to receive a true galvanized coating. The universal custom is to pass the wire, when manufactured for fencing, after it has been cleaned with acid, through a molten bath of zinc, and then through asbestos wipers, as has been described in an earlier part of this paper. The object of the wipers is to remove all excess of zinc and make the coating smooth.

The zinc ordinarily used for fence wire is known as "spelter." It is made of virgin ores and consists of about 99 per cent of zinc, 0.1 per cent of iron, 0.5 per cent of lead, and occasionally cadmium and some other elements, depending on the location of the zinc mine. The ordinary weight of the zinc protective coating per unit weight of wire for fencing purposes is made as small as possible, and will often run as low as from 1 to 1.5 per cent. The temperature of the galvanizing bath should be kept as low as possible to prevent excessive drossing of zinc and disintegration of the metal.

A very much better covering and perhaps a more durable wire can be made by what is known as the double galvanizing process. The double process does not, as its name implies, mean that more than one oating of zinc is put on, but only that about twice as much zinc by weight is carried by the wire. In the double process the wire is drawn much more slowly through the zinc bath and does not pass hrough asbestos wipers, but is smoothed by passing through a shalow bed of slightly damp charcoal powder. Telegraph wire is usually reated by this method and is generally acknowledged to be more durable than fence wire, but it is worth noting at the same time that care is exercised in the manufacture of telegraph wire to keep the manganese low, because the presence of this element increases the lectrical resistance of the wire. The difficulty experienced in rolling ow-manganese steel and the slow rate of speed at which the mill must be run to draw the wire through the zinc bath in the double process adds materially to the cost of the product. It is a question that can not be decided here, whether or not high-grade fence wire is worthy of the same care and consideration that is given to wire which brings a higher price in the market and which is intended for other purposes.

Although, as has been said in an earlier paragraph, it is not the intention to maintain that the weight of the galvanized coating has nothing to do with the lasting quality of fence wire, in view of the evidence which has been collected it is impossible to believe, as many people do believe, that insufficient galvanizing is the whole cause of the difficulty. Among the wire fences that have been under the careful observation of the writer for a long time is one woven-wire fence 5 years old that contains among its twelve horizontal wires, all of one roll, seven wires that are perfectly good from beginning to end, four that are partially rusted, and one that is badly rusted, without a particle of zinc remaining on it. Of the seven perfectly good wires, six are on the bottom. Now, if the theory of electrolysis is left out of the question it would seem that the good wires had received a better coating of zinc than the bad wires. This explanation is not supported either by observation or experiment. Two wires are made in the same mill; pass through the same zinc bath; are wiped off in precisely the same way; chemical analysis shows them to have practically the same weight of zinc covering per pound of metal; and yet one wire will outlast the other 5 to 1 on the fence. It is, however, entirely possible that the perfection with which the manganese and other impurities are distributed may happen to be more perfect in one ingot than it is in another. Within certain practical and possible limits it is probably true that, other things being equal, the wire with the heavier zinc coating per unit of surface area will be the most resistant to weather conditions.

None the less, in the opinion of the writer and for the reasons outlined in the foregoing pages, the problem will not be solved until attention is directed to obtaining the proper conditions in the wire itself. Although the Department of Agriculture can not undertake to make specifications, it is highly probable, now that the attention and interest of manufacturers has been aroused, a substantial improvement in the rust-resisting character of fence wire will follow in the future. One of the prominent manufacturing companies claims to have already solved the problem of making a better wire. If these expectations are justified, and even if such improvements remain to some extent trade secrets, there is no question but that the farmer will soon begin to get the benefit of the better quality of fencing, which will result from the persistent effort on the part of manufacturers to improve their product and distance their competitors.

APPENDIX.

THE MANUFACTURE OF WROUGHT IRON AND THE RELATIVE RESISTANCE TO CORROSION OF WROUGHT IRON AND STEEL.

At a meeting of the American Institute of Mining Engineers, held in Washington, D. C., in May, 1905, Mr. J. P. Roe read a paper on the above subject, and the following discussion took place:

Dr. Charles B. Dudley, *Altoona, Pa.*: Those of us who are using metals continuously can not help noticing at the present time a distinct trend toward a return to the use of wrought iron in place of steel in certain constructions. It is well known that for the last twenty or twenty-five years the trend has been markedly in the other direction. Wherever possible, steel has been substituted for iron, and it may be said with all honesty that the belief and feeling of those who have guided this matter have been that the substitution of a homogeneous, well-made metal like steel for a non-homogeneous metal like wrought iron, which is apt to be full of flaws and bad welds, was not only wise, but clearly a step in the right direction. However, as we have obtained more experience with the use of steel (and I may say that it has apparently taken about twenty years to get this experience) we are finding that in certain constructions steel is not proving to be as satisfactory as we had hoped. This may be due partly to lack of knowledge, which has led us to use steel of a grade not fitted to the work, and it may be partly due to the design, since, when we change from one metal to another, it does not necessarily follow that the same construction and size of parts will give satisfactory results; and it may be partly due to workmanship, since it does not necessarily follow that the two metals can be treated exactly alike. Whatever the cause, the difference in the behavior of the two metals in service, at least in certain constructions, is very clear. We are inclined to think there is a fourth cause, perhaps more important than any of those already mentioned, namely, the nature of the two metals. * * * Iron and steel do not behave alike when subjected to bending stresses. We think it is perfectly safe to say that a well-made iron car axle, the metal of which will show in tensile strength from 48,000 to 52,000 pounds per square inch will stand successfully the same fiber stress as steel of 80,000 to 85,000 pounds tensile strength. Just why this is so I am unable to explain, but there is a very large amount of accumulated experience which seems to indicate that a metal like iron, which is believed to be a bundle of fibers, each one surrounded by slag, and which has within itself the power of the distribution of the strain, is a more reliable metal when subjected to bending stresses than a perfectly homogeneous metal like steel. This is hardly the place or the time to go into a discussion of this phase of the case, and so I close by saying that the present outlook seems to be that, if wrought iron can be made in sufficiently large masses, so that flaws and defective welds will be eliminated, it might again become a successful rival of steel, especially if it can be made at a cost that will permit of commercial competition.

Dr. Allerton S. Cushman, *Washington, D. C.*: My connection with this discussion is rather indirect, because I make no claim to have had very much experience in the problems that are presented to iron and steel men, whether manufacturers or users, but I occupy the position of chemist in the Division of Tests of the Department of Agriculture, and so many complaints have reached the Department as to the lasting quality of modern steel wire which is sold to American farmers for fencing purposes that the Secretary and the Assistant Secretary of Agriculture have interested themselves in the problem, and have asked me to investigate it, or at least to begin the collection of data with a view to making a thorough investigation of the whole subject.

I knew of no reason why modern steel wire should not last as long as the older wires. Inquiries among men who have had a large experience did not lead to any satisfactory source of information. Text-books on the metallurgy of iron and steel contain contradictory statements, and the question seems to be one as yet unanswered.

Several of the influential farmers' journals in the country have taken up the matter, and in every issue we are reminded that something ought to be done. Farmers complain that galvanized steel wire fences go to pieces in two or three years, and yet some of these farmers have fences on their farms which were put up thirty years ago. I am not ready to report upon what we have done so far in any direct way, because the work is very young.

After having examined carefully in the laboratory samples of iron and steel wire that had failed and of wire that had not failed, we noticed that those which had failed contained manganese as high as 0.4 per cent in the large majority of cases, while wires that lasted did not contain manganese at all. If, however, the solution were as simple as that it would not have been a problem, and we realized that this point would have been observed long ago. As a matter of fact, it is not so simple.

We thought that perhaps the best way to begin was to get as pure iron as possible by the Goldschmidt-Thermit process and commence with that, and then see if we could work out a laboratory method of studying the problem. The first thing we did was to make laboratory ingots with different percentages of manganese. By making ingots of definite composition we thought we might perhaps work out a laboratory method of determining the relative rate of oxidation.

As far as we have gone this much seems to be true: Iron which is free from manganese is not so readily oxidized by very dilute solutions of hydrogen peroxide as those irons which contain appreciable amounts of manganese. The very dilute solutions of hydrogen peroxide that we used are not unlike rain water—that is to say, thunder-shower water. It is easy to make in the laboratory solutions of nitric acid, carbonic acid, etc., and thus approximate the conditions that wire is subject to out of doors, i. e., rain water containing small amounts of hydrogen peroxide, carbonic acid, nitric acid, sulphuric acid, and other constituents.

A number of samples have been collected from farmers. Some were found in very good condition and others in extremely bad condition after thirty years of service. We believed that the good wires would prove to have no manganese in them and that the bad wires would run high. As a matter of fact, it did not invariably turn out that way; but I think it is safe to say that in the majority of cases, and especially with the modern steel wires made by the Bessemer process, the presence of manganese does increase the rate of oxidation—that is, manganese has something to do with it directly. With the iron wires, so far as we have gone, it does not look as though the manganese had so much to do with the matter. It naturally occurs to one that the distribution of manganese is the metal may possibly be the cause of the trouble. If we have manganese very evenly distributed throughout the mass of the metal, electrolytic action need not necessarily be set up, but if there be an unevenness in the distribution of the manganese, then electrolytic action leading to pitting and pockmarking of the iron may take place. All we can do is to speculate pending a systematic investigation of the matter, which it seems to me has not yet been made by anyone.

The Department of Agriculture has determined to find out, if possible, why these fence wires go to pieces so rapidly, and hopes that manufacturers will cooperate in discovering the reasons for the trouble.

The wires were badly pitted or pockmarked. If the whole surface of the iron had rusted it would not have been so bad, but in nearly every case the old iron fence wire was badly pitted, and sometimes these pits extended nearly through and then the wire would break. You remember that in the old days they made wire heavier than now. The increased tensile strength of steel enabled them to use less metal for the same strength, and that has something to do with it. Then, further, exposure to the action of the elements plays an important part. To-day they twist the strands of wire, thereby forming little cups where the water is lodged, allowing a rusting point. Making every allowance, there is no doubt that modern wire is not as lasting as it should be.

I am told by men who are using steel pipe that, as compared with iron pipe, steel pipe pits, and there are many in this country who are discontinuing the use of steel pipes for this reason. My experience leads me to the same conclusion that Doctor Dudley has reached; that is to say, that the time is coming when perhaps a return to the older processes is going to yield a metal better suited to certain purposes than the more convenient modern processes.

J. E. Johnson, Jr.: Did you ever make any comparison of the contents in sulphur and manganese? This may be important, because the manganese will be present as sulphide of manganese as long as there is any sulphur to take up, and probably some will be in the form of sulphate.

Doctor Cushman: I realize that the problem is complex and that the inquiry suggested would be very interesting, and, like other collateral investigations not yet executed, must be made before a final solution can be reached. I do not think anyone knows whether the action of the manganese is catalytic in its nature or whether it is due to the mere fact that manganese oxidizes rapidly, or, again, whether the action is electrolytic.

Joseph Hartshorne, *Pottstown, Pa.:* It is, of course, well known that the chemical composition of iron and steel has a great influence upon their resistance to corrosion. For instance, the presence of any nickel retards oxidation, and a sufficient quantity will prevent it entirely. It seems very probable, therefore, that, as suggested by Doctor Raymond, manganese has a decided effect and that it is in favor of oxidation, but I do not remember any report of tests bearing directly on this point.

Other elements undoubtedly exercise considerable influence. In this connection, a series of tests made by Engineer Diesel, of the German torpedo service, are important. They cover the relative corrosion of certain alloys by sea water.[a] Among these alloys was "flusseisen," or soft steel. The results on this material show that phosphorus has a protective effect against corrosion, since the plates with high phosphorus resisted corrosion better than those low in phosphorus. They also show that there is an electrolytic action between plates of different contents of phosphorus when in contact, whereby the low phosphorus plate corrodes much faster than when isolated or in contact with plates containing like amounts of phosphorus.

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[a] Stahl und Eisen, May 30 and June 15, 1904.

The extreme probability that the presence of manganese increases the liability to corrosion, while that of phosphorus decreases it, affords a good reason why puddled iron should resist corrosion better than steel, since iron rarely contains more than a trace of the former element and usually contains very much more of the latter than is allowable in steel.

Like all laboratory experiments in this line, however, those just referred to, while very interesting and important, are merely indicative and not demonstrative. The samples used in such tests are not subjected to the ordinary conditions of practice and the results obtained may or may not correspond to those obtained in practice. For instance, the samples are merely suspended in the attacking medium—such as sea water, dilute solutions of mixed acids, hydrogen peroxide, etc.—in a quiescent state, while in practice the surface is generally subjected to movement and stresses of various kinds. From this it results that the rust is shaken off as it forms and fresh surfaces are continually exposed. I do not mean to assert that this action always hastens corrosion—under some circumstances it might even retard it—but merely to point out the inherent differences between the two sets of conditions.

Such experiments can only show the relative rates of corrosion of the substances investigated under the conditions given. They may indicate, perhaps very definitely, the probable rate at which the substance will corrode in practice, but can not determine it with, say, anything like the accuracy that an analysis for phosphorus will show the capacity to resist shock. The only way in which this question can ever be settled, it seems to me, is by the collation of as many examples from actual practice as possible, preferably those in which iron and steel are used side by side under the same conditions, either intentionally for comparison or incidentally.

As examples of what I mean I will refer to two incidents in my own experience, although many of you have probably met with the same. A Bessemer steel works was built under my supervision in 1885, the roof and sides of which were made of corrugated iron sheets of heavy gauge. They received two coats of paint on both sides before erection and one on the outside when in place. The sheets were put on in the latter part of 1885; blowing began in July, 1886, and ceased finally in August, 1893. Since that time most of the buildings have been entirely neglected. Extensions were erected at various times, generally after 1889, for which steel sheets of the same gauge were used and treated in the same way. The parts of the first roof (of iron sheets) immediately over the cupolas and converters were renewed twice during the eight years of running, but the rest of it was not touched, except to repaint it once on the outside. Much of the roof and a still larger proportion of the sides will still turn water after twenty years, although they have not been painted for eleven years and the wind has had free play with the sheets, which were never fastened if they got loose. None of the steel plates lasted over four years, and a part which was reroofed with steel sheets in May, 1901, now requires renewal.

In 1885 a smoke flue, made of galvanized sheet iron, was put in with the furnace of the house I then occupied, and when I left it in 1893 it was apparently in as good condition as when new. A flue similar to the other in every respect, except that it was made of sheet steel, was put into my new house in 1893, in connection with a furnace of the same size and make and under the same general conditions of firing, but in a drier cellar. This flue has been renewed twice within twelve years since then, on account of having rusted out.

In my experience with tinsmiths and roofers, I find that there is a general omplaint that the galvanized and tin sheets of the present do not last anything ke as long as those made twenty-five or thirty years ago. The old men who ave had experience with both kinds say that the present sheets last only a ourth or a fifth as long as the old ones. Only a few attribute this to the old eets being made of iron and the present ones of steel; but, on the other hand, ew of them know this fact or appreciate what it means.

I was very glad to hear Doctor Dudley, whose opportunities for investigation nd observation are unsurpassed, indorse the remark I made this morning in nnouncing this discussion. My own investigations had led me to believe that on was the better material for many of the purposes to which steel is now pplied, and it seemed to me that the decided trend of opinion, not only among adesmen, but also among engineers and investigators, was in the same direc-on. If this opinion be warranted by the facts, as now, more than ever, I hink it is, then the use of iron must largely increase in the near future.

MR. N. B. WITTMAN, *Philadelphia, Pa.*: Several years ago, during the latter ighties and up to the early nineties, the substitution of [illegible] Bessemer and pen-hearth soft steel for purposes previously held by wrought iron caused any capable observers to hold the view that wrought iron would soon [illegible] n unimportant part in metallurgy. In looking over the Directory of the merican Iron and Steel Association, the rapid decline in the number of active uddling furnaces reported up to the year 1896 will be noted. The entire with-rawal of such important firms as the Carnegie, Cambria Steel, Jones & Laugh-ins, and others from puddling was responsible for the greater part of the ecline. Since 1896 this movement on the whole has been checked, and a tudy of the "directory" will show a very important increase in the number f active puddling furnaces in certain localities and among [illegible] irms who have held to iron for certain purposes [illegible]. In astern Pennsylvania to-day many new puddling furnaces are being built, and ven in Pittsburg many of the firms which have held to the iron business are arger puddlers than in 1896.

The superior shopworking qualities of soft steel, together with [illegible] physical tests and analyses, naturally [illegible] the test of time unquestionably shows that for many purposes it is not so durable as iron. Several years ago the iron nail was practically driven out of the market by the [illegible] nail; after a time it was found that structures [illegible] with steel nails would not hold because the nails rusted off under the heads very rapidly; it was then found that for scaffolding and similar purposes [illegible] power than cut-iron nails, and a demand has again sprung up for the [illegible] nail; the tonnage of the latter at present produced is [illegible] ompared with what it was several years ago, and is still growing.

For wrought-iron pipe, notwithstanding the [illegible] emand has been sufficient to employ several [illegible] he manufacture of this product. [illegible] ry, and, although almost all new machinery [illegible] ubes, principally because they [illegible] and are pre-rred for easy working, the general experience [illegible] e not so durable as the charcoal-iron [illegible] the greater part of [illegible] ubes are made from charcoal-iron [illegible] portant steel manufacturer [illegible] on, who will not have a [illegible] the buildings.

FARMERS' BULLETINS.

The following is a list of the Farmers' Bulletins available for distribution, showing the number and title of each. Copies will be sent to any address on application to any Senator, Representative, or Delegate in Congress, or to the Secretary of Agriculture, Washington, D. C.

No. 22. The Feeding of Farm Animals. No. 24. Hog Cholera and Swine Plague. No. 25. Peanut Culture and Uses. No. 27. Flax for Seed and Fiber. No. 28. Weeds: And How to Kill Them. No. 29. Souring and Other Changes in Milk. No. 30. Grape Diseases on the Pacific Coast. No. 32. Silos and Silage. No. 33. Peach Growing for Market. No. 34. Meats: Composition and Cooking. No. 35. Potato Culture. No. 36. Cotton Seed and Its Products. No. 37. Kafir Corn: Culture and Uses. No. 38. Spraying for Fruit Diseases. No. 39. Onion Culture. No. 41. Fowls: Care and Feeding. No. 43. Sewage Disposal on the Farm. No. 44. Commercial Fertilizers. No. 46. Irrigation in Humid Climates. No. 47. Insects Affecting the Cotton Plant. No. 48. The Manuring of Cotton. No. 49. Sheep Feeding. No. 50. Sorghum as a Forage Crop. No. 51. Standard Varieties of Chickens. No. 52. The Sugar Beet. No. 54. Some Common Birds. No. 55. The Dairy Herd. No. 56. Experiment Station Work—I. No. 57. Butter Making on the Farm. No. 58. The Soy Bean as a Forage Crop. No. 59. Bee Keeping. No. 60. Methods of Curing Tobacco. No. 61. Asparagus Culture. No. 62. Marketing Farm Produce. No. 63. Care of Milk on the Farm. No. 64. Ducks and Geese. No. 65. Experiment Station Work—II. No. 66. Meadows and Pastures. No. 68. The Black Rot of the Cabbage. No. 69. Experiment Station Work—III. No. 70. Insect Enemies of the Grape. No. 71. Essentials in Beef Production. No. 72. Cattle Ranges of the Southwest. No. 73. Experiment Station Work—IV. No. 74. Milk as Food. No. 77. The Liming of Soils. No. 78. Experiment Station Work—V. No. 79. Experiment Station Work—VI. No. 80. The Peach Twig-borer. No. 81. Corn Culture in the South. No. 82. The Culture of Tobacco. No. 83. Tobacco Soils. No. 84. Experiment Station Work—VII. No. 85. Fish as Food. No. 86. Thirty Poisonous Plants. No. 87. Experiment Station Work—VIII. No. 88. Alkali Lands. No. 91. Potato Diseases and Treatment. No. 92. Experiment Station Work—IX. No. 93. Sugar as Food. No. 94. The Vegetable Garden. No. 95. Good Roads for Farmers. No. 96. Raising Sheep for Mutton. No. 97. Experiment Station Work—X. No. 98. Suggestions to Southern Farmers. No. 99. Insect Enemies of Shade Trees. No. 100. Hog Raising in the South. No. 101. Millets. No. 102. Southern Forage Plants. No. 103. Experiment Station Work—XI. No. 104. Notes on Frost. No. 105. Experiment Station Work—XII. No. 106. Breeds of Dairy Cattle. No. 107. Experiment Station Work—XIII. No. 108. Saltbushes. No. 109. Farmers' Reading Courses. No. 110. Rice Culture in the United States. No. 111. Farmers' Interest in Good Seed. No. 112. Bread and Bread Making. No. 113. The Apple and How to Grow It. No. 114. Experiment Station Work—XIV. No. 115. Hop Culture in California. No. 116. Irrigation in Fruit Growing. No. 118. Grape Growing in the South. No. 119. Experiment Station Work—XV. No. 120. Insects Affecting Tobacco. No. 121. Beans, Peas, and other Legumes as Food. No. 122. Experiment Station Work—XVI. No. 123. Red Clover Seed: Information for Purchasers. No. 124. Experiment Station Work—XVII. No. 125. Protection of Food Products from Injurious Temperatures. No. 126. Practical Suggestions for Farm Buildings. No. 127. Important Insecticides. No. 128. Eggs and Their Uses as Food. No. 129. Sweet Potatoes. No. 131. Household Tests for Detection of Oleomargarine and Renovated Butter. No. 132. Insect Enemies of Growing Wheat. No. 133. Experiment Station Work—XVIII. No. 134. Tree Planting in Rural School Grounds. No. 135. Sorghum Sirup Manufacture. No. 136. Earth Roads. No. 137. The Angora Goat. No. 138. Irrigation in Field and Garden. No. 139. Emmer: A Grain for the Semiarid Regions. No. 140. Pineapple Growing. No. 141. Poultry Raising on the Farm. No. 142. Principles of Nutrition and Nutritive Value of Food. No. 143. Conformation of Beef and Dairy Cattle. No. 144. Experiment Station Work—XIX. No. 145. Carbon Bisulphid as an Insecticide. No. 146. Insecticides and Fungicides. No. 147. 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No. 176. Cranberry Culture. No. 177. Squab Raising. No. 178. Insects Injurious in Cranberry Culture. No. 179. Horseshoeing. No. 181. Pruning. No. 182. Poultry as Food. No. 183. Meat on the Farm—Butchering, Curing, etc. No. 184. Marketing Live Stock. No. 185. Beautifying the Home Grounds. No. 186. Experiment Station Work—XXIII. No. 187. Drainage of Farm Lands. No. 188. Weeds Used in Medicine. No. 190. Experiment Station Work—XXIV. No. 192. Barnyard Manure. No. 193. Experiment Station Work—XXV. No. 194. Alfalfa Seed. No. 195. Annual Flowering Plants. No. 196. Usefulness of the American Toad. No. 197. Importation of Game Birds and Eggs for Propagation. No. 198. Strawberries. No. 199. Corn Growing. No. 200. Turkeys. No. 201. Cream Separator on Western Farms. No. 202. Experiment Station Work—XXVI. No. 203. Canned Fruits, Preserves, and Jellies. No. 204. The Cultivation of Mushrooms. No. 205. Pig Management. No. 206. Milk Fever and its Treatment. No. 208. Varieties of Fruits Recommended for Planting. No. 209. Controlling the Boll Weevil in Cotton Seed and at Ginneries. No. 210. Experiment Station Work—XXVII. No. 211. The Use of Paris Green in Controlling the Cotton Boll Weevil. No. 212. The Cotton Bollworm—1904. No. 213. Raspberries. No. 214. Beneficial Bacteria for Leguminous Crops. No. 215. Alfalfa in the Eastern States. No. 216. Control of the Cotton Boll Weevil. No. 217. Essential Steps in Securing an Early Crop of Cotton. No. 218. The School Garden. No. 219. Lessons taught by the Grain-Rust Epidemic of 1904. No. 220. Tomatoes. No. 221. Fungous Diseases of the Cranberry. No. 222. Experiment Station Work—XXVIII. No. 223. Miscellaneous Cotton Insects in Texas. No. 224. Canadian Field Peas. No. 225. Experiment Station Work—XXIX. No. 226. Relation of Coyotes to Stock Raising in the West. No. 227. Experiment Station Work—XXX. No. 228. Forest Planting and Farm Management. No. 229. The Production of Good Seed Corn. No. 230. Game Laws for 1905. No. 231. Spraying for Cucumber and Melon Diseases. No. 232. Okra: Its Culture and Uses. No. 233. Experiment Station Work—XXXI. No. 234. The Guinea Fowl and Its Use as Food. No. 235. Cement Mortar and Concrete. No. 236. Incubation and Incubators.

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In carrying out this test the following directions should be adhered to minutely:

A fair sample of the wire to be tested, about 6 inches in length, is thoroughly cleaned from grease and dirt by washing and careful wiping. A nearly saturated solution of copper sulphate (24° Baumé at 60° F.), which can be obtained from any chemist or druggist, is poured into a clean dry glass to a depth of about 3 inches. The clean wire sample is immersed with a quick motion in the copper solution, and at the end of exactly five seconds quickly withdrawn and at once dipped into pure water and wiped with a bit of clean filter paper or soft cotton cloth. The immersion should be timed with a stop watch if possible. As long as no copper is visible plated out on the iron, the five-second immersions are repeated until the copper deposit which begins to form wipes off with difficulty. At this point a series of rapid (two-second) immersions are made, with alternate wipings, until bright streaks of metallic copper, which can not be wiped off the wire, appear. The total time of immersion in minutes and fractions of a minute is taken as an indication of the percentage of zinc carried by the wire. Thus, if 150 seconds' immersion were necessary to reach the end point, the weight of the galvanizing would be called 2.5 per cent. It must be remembered that although the results of this test are approximate only, their value depends entirely upon careful accuracy in following out the directions. No attention should be paid to the copper which plates at the extreme tip end of the sample where the zinc has been cut away. If a user of fencing wishes to purchase wire advertised as extra heavy galvanized, he can tell by this method, with a fair degree of accuracy, with what he is being supplied. Some telegraph companies specify that telegraph wire must stand four-minute immersions, equal to about 4 per cent of zinc.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Plant Industry,
Office of the Chief.

Washington, D. C., November 29, 1905.

Sir: I have the honor to transmit herewith a paper entitled "Inoculation of Legumes," and to recommend that it be published as a Farmers' Bulletin. This paper was prepared by Mr. Karl F. Kellerman, Physiologist in Charge of the Laboratory of Plant Physiology, and Mr. T. R. Robinson, Assistant in Physiology in the Office of Vegetable Pathological and Physiological Investigations, and was submitted by Mr. Albert F. Woods, the Pathologist and Physiologist, with a view to publication.

Special attention is called to the method of distributing bacteriologically pure cultures in a nitrogen-free nutrient solution in hermetically sealed tubes. Laboratory tests show that cultures of this kind may be readily handled and shipped and that they possess advantages over cultures dried on cotton.

Respectfully,

B. T. Galloway,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

INOCULATION OF LEGUMES.

INTRODUCTION.

The method of distributing practically pure cultures of nitrogen-fixing bacteria dried on cotton has not proved entirely satisfactory, owing to varying conditions of air during transit in the mails and to certain matters connected with laboratory technique. While the number of unsuccessful attempts to secure inoculation by users of cotton cultures sent out by the Department of Agriculture is small, it has been recognized that the methods of preparing the organisms and distributing them were open to improvements. Investigations have been under way for some time with a view to improving the methods followed, and as a result the Department is now prepared to send out bacteriologically pure cultures in small tubes hermetically sealed.

The experiments carried on by the Department of Agriculture have demonstrated the fact that by the proper use of practically pure cultures the nodule-forming bacteria are actually carried into the soil. These bacteria are able to form root nodules, and where other conditions are favorable the inoculation thus brought about makes possible the growth of a legume in soils where it had failed previously from lack of bacteria. The original cultures used, however, must be prepared with the utmost care and with a view to preserving or increasing their natural power of nitrogen fixation rather than merely to make them grow under favorable conditions.

DIRECTIONS FOR USING CULTURES.

The following directions will accompany the packages distributed under this new plan:

TO PREPARE THE CULTURE LIQUID.

Put 1 gallon of clean water (preferably luke-warm rain water) in a clean bucket or jar and add 3 heaping teaspoonfuls of granulated or brown sugar; then add the tablet contained in the small envelope No. 1. Allow all to dissolve, stirring with a clean rod or spoon if necessary.

Carefully open package No. 2, breaking off the top of the glass tube, being careful not to spill the liquid, and pour the contents into the solution. Cover the vessel with a paper or muslin cloth to protect from dust, and set aside in a warm place for twenty-four hours. About 70° F. is the best temperature. Do not heat the solution or you will kill the bacteria; it should never be as warm as blood heat.

After twenty-four hours add the tablet in envelope No. 3 and allow the mixture to stand another twenty-four hours. The liquid should now be faintly cloudy and ready for use. If sufficient growth has not taken place to bring about this cloudiness, further time should be given, not to exceed two days.

TO INOCULATE SEED.

Take just enough of the solution to moisten the seed (1 gallon will moisten 2 bushels of seed). Stir thoroughly, so that all the seeds will be touched by the solution. Spread out the seeds in a shady place, rake over occasionally [illegible] and plant just as you would untreated seed. If bad weather should prevent planting at once, the inoculated seed, thoroughly dried and properly stored, may usually be kept without deterioration for several weeks.

TO INOCULATE SOIL.

Take enough dry soil so that the solution will merely moisten it. Mix thoroughly to moisten every particle, and mix this with four or five times as much—say half a wagonload. Spread this inoculated soil thinly and evenly over the prepared ground exactly as if spreading fertilizer. The inoculated soil should be harrowed in immediately.

Either of the above methods may be used as convenient.

INFORMATION FOR USERS OF INOCULATING MATERIAL.

The enclosed package marked "No. 2" contains a pure liquid culture of bacteria. This culture treated according to directions will produce a liquid culture which, if used with the proper plants, is capable of rendering available to these plants the free nitrogen of the air. This is accomplished through the formation of root nodules.

These bacteria are capable of making up for a deficiency of soil nitrogen, but where other elements, such as potash and phosphoric acid, are lacking, inoculation will not do away with the necessity for fertilizers containing these substances. Mineral fertilizers, however, should never be applied so as to come into direct contact with inoculated seed. The action of concentrated fertilizers drilled in with inoculated seeds is injurious; this is especially true if the seeds should be sown wet after treating with liquid culture. Floors used for drying inoculated seeds should be thoroughly scrubbed and rinsed, especially if the same floor space has served for mixing fertilizers. The liquid on the seeds is apt to dissolve chemicals contained in the fertilizers, and the effect might be disastrous alike to seeds and bacteria. Moistened seeds should never be dried by mixing with pulverized fertilizers; if it seems desirable to hasten drying, clean sand or dirt is the best material to use. Fertilizers should be spread and mixed with the soil or drilled previous to sowing the seed, and if the drill has been used for this purpose all parts with which the seeds may come in contact should be cleaned.

This material is furnished you with the understanding that you will carefully follow instructions in its use and will report your success or failure to secure good inoculation. Note the presence or absence of nodules on the roots of inoculated and uninoculated plants.

WHEN INOCULATION IS DESIRABLE.

) If a soil is low in organic matter and has not previously borne minous crops.

:) If legumes previously grown on the same land were devoid of iles.

) If the legume to be sown belongs to a species not closely related ie previously grown on the same soil.

WHEN INOCULATION MAY PROVE ADVANTAGEOUS.

) If the soil produces a sickly growth of legumes, even though · roots show some nodules.

) If a leguminous crop has made a stand but gives evidence of ire, due to the absence of root nodules. Under such conditions advisable to apply the culture liquid by spraying or, better, by lressing the land with soil moistened with the culture liquid, as ained in the directions.

WHEN INOCULATION IS USELESS.

) If the legumes usually grown are producing average yields ie roots show nodules in abundance.

:) If the soil is rich in nitrogen. It is neither necessary nor itable to inoculate a soil rich in nitrogen; few nodules are ied under these conditions.

ltures of nitrogen-fixing bacteria are not to be regarded in the of nitrogenous fertilizers, increasing yields under all average itions. The bacteria do not contain nitrogen. If conditions are rable, they render nitrogen obtained from the air available for legume.

WHEN INOCULATION WILL BE A FAILURE.

) If the directions are not studied intelligently and followed fully.

:) If the soil is acid and in need of lime. Liming to correct ity is as important for the proper activity of the bacteria as for growth of the plants.

) If the soil needs fertilizers, such as potash, phosphoric acid, or . The activity of the bacteria in securing nitrogen from the ind rendering it available to the legumes will not take the place ich fertilizing elements as potash and phosphorus.

must be remembered that inoculation will not overcome results to bad seed, improper preparation and cultivation of ground, and ledly adverse conditions of weather or climate. Before attempting to inoculate a new crop, the farmer first should inform himself thoroughly concerning the proper handling of the crop itself; otherwise failure is almost certain. As an illustration, sowing alfalfa on hastily prepared land, on land foul with weeds, on acid soils, or soils underlaid with hardpan is contrary to accepted practice. Free publications covering the essential points in growing all common legumes may be obtained from the State experiment stations and from the United States Department of Agriculture.

KEEPING CULTURES FOR FUTURE USE.

The possibility of farmers keeping cultures from one year to another has been suggested. *This practice is not to be advised in any case.* For good results it is necessary to start with a fresh, pure culture. The pure culture, moreover, can be prepared only by a trained bacteriologist with laboratory facilities.

CONFUSION OF NEMATODE GALLS WITH NODULES.

Nematode galls, or root knots, are often mistaken for nodules, which they resemble in appearance. The nematode gall is extremely injurious, and in regions where it has been known to exist it is unwise to plant crops favorable to the development of the pest. Nearly all of the legumes should be avoided. This is important not only because the legumes susceptible to nematode attack are themselves injured, but chiefly because they furnish conditions favorable to the rapid development and multiplication of the nematode worms, and these may become a serious menace to succeeding crops or to orchard stock, which, under ordinary conditions, they would scarcely injure. There are, however, some resistant varieties[a] upon which the nematode worm can not develop, and in infested regions these resistant varieties should be used exclusively. If a leguminous crop with its roots covered with what are apparently nodules makes a sickly growth, or if there is doubt as to whether a legume is inoculated or infested with nematodes, samples for examination should be forwarded to the Department of Agriculture.

DANGER IN INOCULATION BY SOIL TRANSFER.

Very satisfactory inoculations have been obtained by transferring soil from old fields where legumes have been grown, but there are dangers incident to such soil transfer which should be noted.

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[a] The most important and generally useful resistant variety is the Iron cowpea (*Vigna sinensis*). In the Southern States the velvet bean (*Mucuna utilis*) and Florida beggar weed (*Meibomia mollis*) are valuable.

The source of supply should be very definitely known, and in no case should soil be used from fields which have previously borne any crops affected with a fungous disease, a bacterial disease, or with nematodes. Numerous animal and plant parasites live in the soil for years and are established in so many localities that it is manifestly unwise to ship soil indiscriminately from one portion of the country to another.

Of scarcely less importance is the danger of disseminating noxious weeds and insect pests through this plan of inoculating by means of natural soils. Even though weeds may not have been serious in the first field, the great number of dormant seeds requiring but a slight change in surroundings to produce germination is always a menace.

If soil[a] is to be used, however, whether obtained from near-by fields or shipped long distances, the evidence should be clear that the soil is free from the objections mentioned above.

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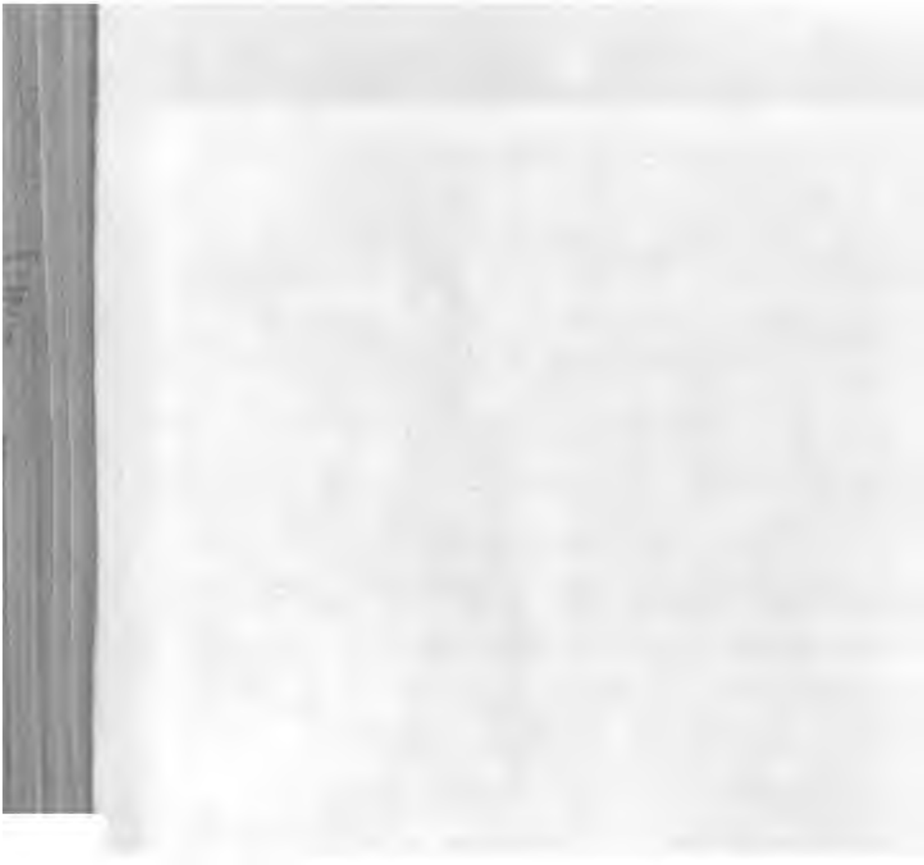
[a] The amount of soil from a thoroughly inoculated field regarded as sufficient for inoculating an acre of land for alfalfa, for instance, is variously placed at 200 to 500 pounds.



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